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Constructionline

editor's letter

The Intergovernmental Panel on Climate Change's 5th assessment report (2014) singled out the passive house standard as one of the key climate change mitigation options available for buildings. This carries real weight: the scientific body acting on behalf of the world's governments has concluded that passive house is a key tool in the climate change fight.

If we're serious about addressing climate change, we need to back solutions that actually perform. Attempts at low energy building have a long history of failing to deliver, with a performance gap existing between designed and actual energy use for a variety of reasons. Estimates vary greatly, but UK studies indicate that non domestic buildings may be consuming up to or more than twice the amount of energy predicted at design stage, with dwellings seeing up to 100% higher heat loss than predicted. According to a source in SEAI, Irish homes that have received energy upgrade grants have seen performance gaps of 30 to 70%, with higher disparity in fuel poor households.

To their credit the last UK government resolved to address this issue, with the commitment that by 2020 90% of all new homes in England would perform as well as or better than design assumption in terms of energy use. (It's critical that the new government retains this commitment, to ensure that the promised zero carbon homes target doesn't end up falling short.) With new homes in Ireland, we don't know how big the performance gap is. Only once in the history of the state has the government checked the actual energy performance of a sample of new homes against the targets in building regulations, as part of SEAI's 2005 Energy Performance Survey of Irish Housing. This study found actual heating bills in homes getting progressively lower in newer homes up until the homes built post 1997, which showed a 16% increase in bills compared to the post 1991 homes – a remarkable finding given the rationale that higher insulation standards in 1997 building regulations should have helped to ensure lower energy use.

I recently asked the Irish Department of the Environment if they had undertaken monitoring studies to check how homes subject to current or recent versions of Part L and F were performing in terms of energy use and ventilation. The department said that "The role of the Minister is to set reasonable and appropriate minimum technical standards in relation to conservation of fuel and energy and ventilation […]. Compliance with these minimum statutory requirements is the responsibility of owners, builders and designers. Enforcement is a matter for the relevant local building control authorities[..]." But how can the minister set "appropriate minimum technical standards" without calibrating them against performance data from real buildings?

Passive houses on the other hand appear not to suffer from the performance gap. A review by English architect Mark Siddall of post occupancy heating data on 228 passive houses showed a mean heating consumption of 15.45 kWh/m^2/yr – exactly in line with the space heating target for passive houses.

But as Kate de Selincourt's report on mechanical ventilation in this issue demonstrates, performance gaps also exist between assumed and actual ventilation performance, with indoor air quality implications. This piece – which can be read as a companion piece to her damning evidence review on non-mechanical or 'natural' ventilation from issue six of Passive House Plus –shows that for mechanical ventilation to perform properly, quality assurance approaches such as those required for passive house certification are critical.

Regards,
the editor

International PASSIVE HOUSE Association iPHA

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2012 Business magazine of the year - Irish Magazine Awards

Jeff Colley: winner green leader award -Green Awards 2010

Construct Ireland: winner green communications award -Green Awards 2010

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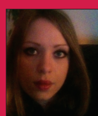

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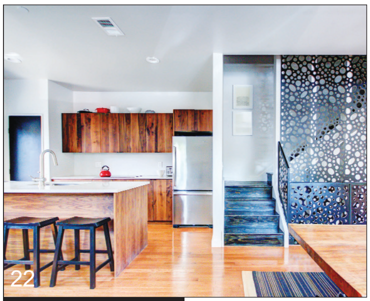
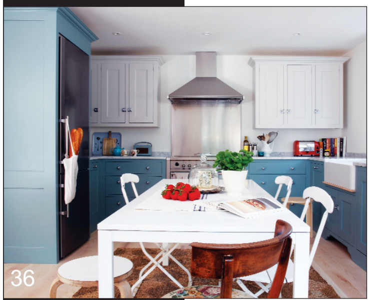
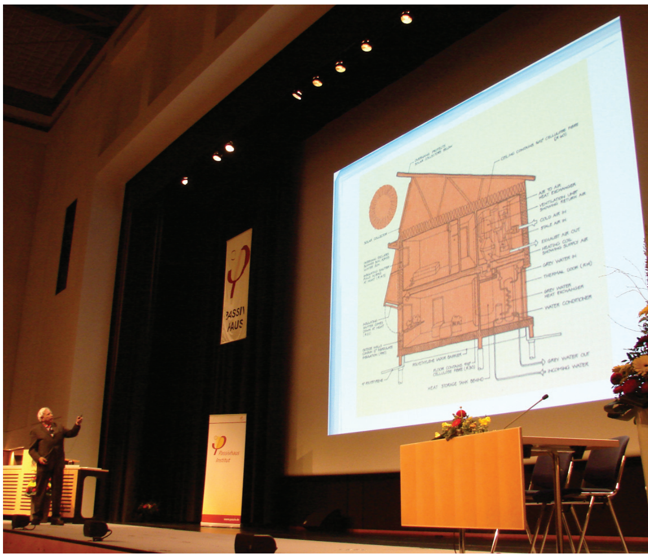




News

International passive house conference focuses on renewables & retrofit

Words: Ben Adam Smith



Leipzig, one of many German municipalities that has embraced the passive house standard, was the location for the 19th International Passive House Conference. Once again energy efficiency was hailed as essential for the transition to a sustainable future.

From the outset of the conference, it was clear that this was not just the goal of Germany's construction industry, but that it also stemmed directly from government officials and local leaders. Dr Frank Heidrich from the Federal Ministry for Economic Affairs thanked the Passive House Institute for its advice on policy, affirming that its strategy was to emphasise energy efficiency alongside renewable energy. "We believe the passive house concept is future-proof," he said.

Indeed, a key theme of the conference was how the passive house standard can embrace renewable energy as well as energy efficiency. Last year the Passive House Institute developed two new classes for certification which take into account energy generated on site by renewables, and these were outlined by Dr Benjamin Krick. Alongside the traditional Passive House Classic standard, the Passive House Plus and Passive House Premium categories now consider energy gains from renewables, so long as they meet clearly defined criteria.

Meanwhile Passive House Institute director Dr Wolfgang Feist stressed the importance of economic feasibility in both new build and retrofit, and said that this was being helped by the increasing availability of certified components. "Today the investment costs for improved efficiency of building components are exceptionally low," he said. "The cost difference is more than compensated through the saved energy costs." Presentations from practitioners around the world backed up the savings that could be achieved, and shared experience of best practice for design and installation.

Workshops presenting case studies and findings from two EU projects – EuroPHit (step-by-step refurbishments) and Passreg (passive house regions with renewable energy) – highlighted the EU's commitment to improving existing buildings. Tomas O'Leary from the Passive House Academy made a plea for building owners to avoid shallow retrofits, because they lock in inefficiencies for decades. Instead he urged a path of mapping out a deep upgrade and doing each phase right — or not at all: "Some are building to Enerphit in one go, others are tackling it bit by bit," he said.

O'Leary also pointed out that there are products needed for retrofitting that have not even been invented yet. This is where the Component Award 2015 showed its value, driving innovation where it is needed. The focus this year was on high quality windows suitable for retrofit, and numerous companies took up the gauntlet with Optiwin and Smartwin jointly taking first place. Next year the challenge will be how ventilation for residential buildings can be optimised.

The conference was also notable for the thread dedicated to passive house schemes in China. There was much interest in passive house projects in such a key emerging economy, where a great deal of construction is currently taking place.

In the closing plenary session Dr Feist recapped on the many seminars that demonstrated successful passive house projects from around the world. He described retrofit as an opportunity to improve the architecture of existing buildings at the same time as addressing energy performance. Reimar von Meding's Enerphit refurb of an office building in the Netherlands was one project he referred to as "a thrilling example" of what can be achieved.

Dr Feist also displayed a graph he had put together a number of years previously, which detailed how passive house costs were likely to come down over time. He said that this projection had held true, and that Germany was currently entering the sweet economic spot of the passive house learning curve.

Proceedings ended with the Pioneer Award, which went to Canadian mechanical engineer Harold Orr, one of the driving forces behind the Saskatchewan Conservation House. Built in Regina in 1977, this house was significant because of its high levels of insulation and airtight building envelope. The project even led to the creation of the blower door machine in order to measure its air leakage. Among the other firsts on the project which have since been adopted into the modern passive house standard was the creation of a heat recovery ventilator.

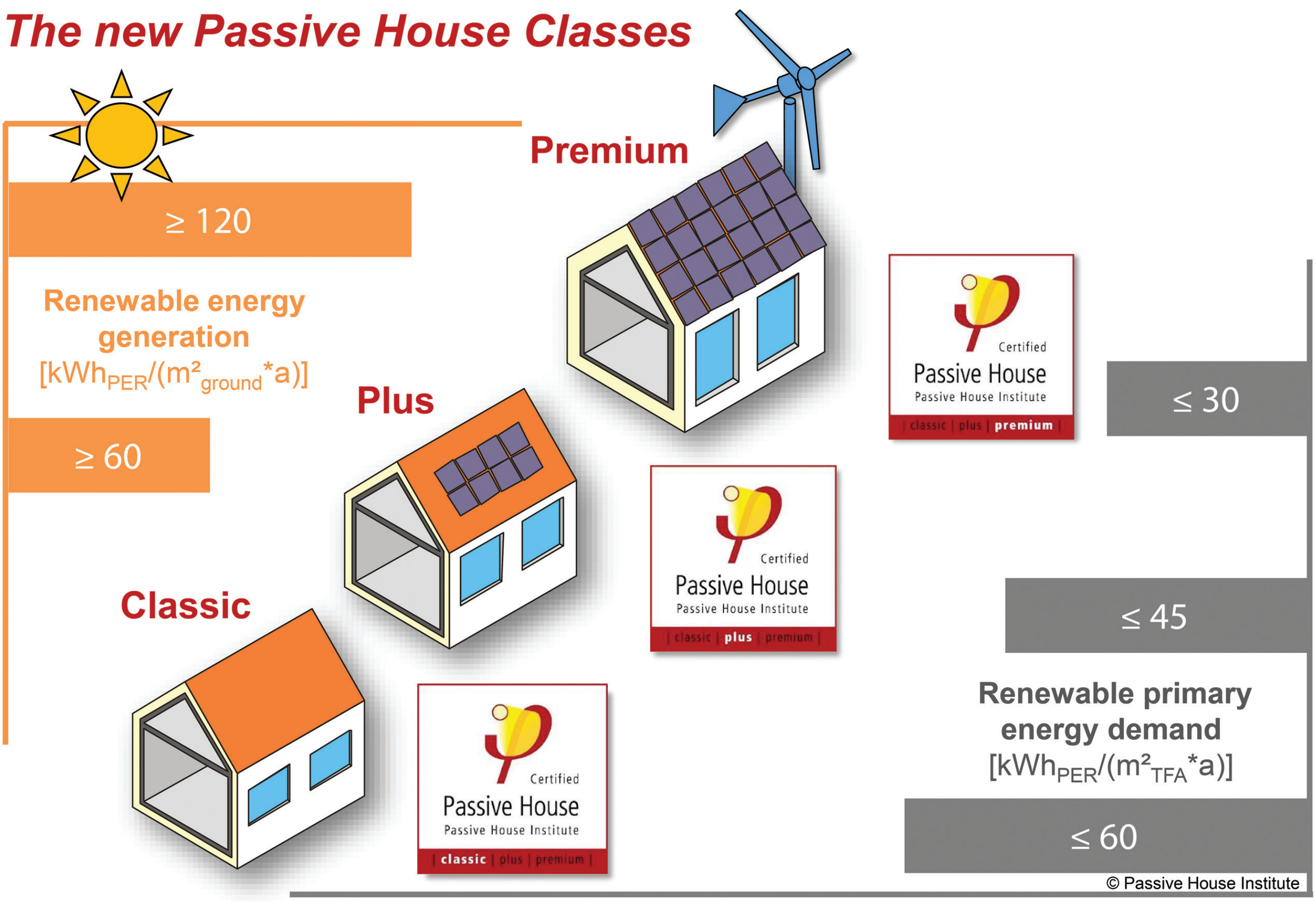
Mr Orr's speech highlighted the many experimental aspects of the project, which included failures too, such as the solar thermal collectors which were removed when the house was eventually sold. But nearly 40 years on the house is still performing well, and the investment in the fabric of the building has been paid off many times over.

The 20th International Passive House Conference returns to its roots next year when it moves to Darmstadt, home of the Passive House Institute.

(above) Harold Orr picked up the Pioneer Award for the Saskatchewan Conservation House, a pioneering low energy house built in 1977 that's still performing nearly 40 years later

News

New passive house categories aim for NZEB & beyond



The Passive House Institute has announced the launch of its two new certification categories, 'passive house plus' and 'passive house premium', which recognise on-site renewable energy generation. The institute provided details of the categories at the International Passive House Conference in Leipzig in April. The new certification categories are incorporated into version nine of PHPP, the latest version of the passive house design and evaluation software.

The new classes represent a recognition by the institute that the passive house sector needs to tackle domestic hot water and electricity usage as EU deadlines for nearly zero energy buildings inch closer – while ensuring that approaches to NZEB don't fall short on thermal comfort, by focusing too much emphasis on energy production over energy reduction.

"The demand of heating energy is greatly reduced in a passive house; therefore the consumption for hot water and domestic electricity is all the more significant. In the new evaluation, this is taken into account in a meaningful and future oriented way," said Dr Wolfgang Feist, director of the Passive House Institute.

The new categories anticipate a future societal transition to 100% renewable energy by evaluating 'primary energy renewable' (PER) demand instead of traditional primary energy demand. A house in the 'passive house plus' category will be able to consume a maximum of 45 kWh/m^2/yr PER, and will be required to generate at least 60 kWh/m^2/yr from on site renewables. A house in the 'passive house premium' category can only consume a maximum of 30 kWh/m^2/yr, and will be required to generate at least 120kWh/m^2/yr on site. In the traditional 'passive house classic' category, buildings will only be allowed to consume a maximum of 60kWh/m^2/yr, but will not be required to generate their own electricity.

While the figures seem to indicate that 'plus' and 'premium' categories require more generation of on-site renewables than consumption of electricity, the PER figure is calculated using a building's total floor area, while on site micro generation instead uses the building's footprint. This means that while a typical house or other single-storey building that meets either standard is likely to be energy positive in terms of its renewable energy production, a multi-storey building might not be.

The PER factor takes account of the fact that the primary energy of renewable energy will vary, depending on the lag between generation and usage. For instance, while solar PV tends to be most productive at a time of peak consumption – due to air conditioning use on hot days – wind and renewable other energy sources may at times produce when demand is low, meaning storage losses, which need to be taken into account. As a consequence the PER factor for various electricity loads will vary, to take account of how renewable energy generation is likely to match up to usage.

Given that world-wide electricity grids are still largely powered by fossil fuels, PHPP still also includes a traditional assessment of primary energy demand based on non renewable electricity – meaning that the 120 kWh/m^2/yr target for regular passive houses will remain unchanged.

A statement from the Passive House Institute on the new certification categories said: "Over a third of the total energy consumed in developed countries is required for operating buildings, especially to heat them. This consumption can be reduced by up to 90% using passive house technology, and the remaining demand can be met sustainably using renewable energy. Hence, the passive house standard isn't just an attractive solution for the energy transition; with the introduction of passive house plus and passive house premium, it is also a blueprint for the nearly zero-energy buildings (NZEBs) stipulated in the European [Energy Performance of] Buildings Directive, which will come into effect in 2021."

News

UK Passivhaus Awards to discuss performance of past winners

The third annual UK Passivhaus Awards take place on Tuesday, 7 July in London at the Residence of the Austrian Ambassador. The shortlisted projects in the three categories — big projects, small projects and retrofits — were on the verge of being announced at the time of going to press.

The awards this year are sponsored by Kingspan, Munster Joinery and Ecology Building Society, and supported by Advantage Austria and Passive House Plus magazine.

The awards aim to celebrate the design and performance of passive house buildings in the UK. They will highlight that passive house can be used on any building type to create beautiful buildings that address health and well-being, energy efficiency and occupant comfort issues.

This year's judges are Jon Bootland of the Passivhaus Trust, Nick Grant of Elemental Solutions, Jon Seaman of Integrity Buildings, and Lynne Sullivan of SustainablyByDesign.

As a special feature at the 2015 awards ceremony, the PHT will also will be taking a 'reflective' look back at the first UK Passivhaus Award winners from 2012 – pioneering examples set by Parsons + Whitley's Wimbish housing scheme for Hastoe, Architype's Oakmeadow primary school, and Bere Architects' Mildmay Centre. The event will feature presentations on how the three projects have performed since completion.

"The main objective of the UK Passivhaus Awards is to celebrate exemplar projects that meet the standard, not only on form, function, and innovation, but crucially how they perform," said a spokesperson for the trust.

Limited tickets are now available for the awards ceremony priced at £50 plus VAT. Priority will be given to Passivhaus Trust members. Members may purchase more than one ticket and purchase tickets for guests.

(bottom left) Post occupancy updates on the 2012 winners – Parsons + Whitley's Wimbish housing scheme, (bottom right) Architype's Oakmeadow primary school, and (top) Bere Architects' Mildmay Centre – will place performance front and centre at this year's UK Passivhaus Awards

Photos: (top) Tim Crocker; (bottom left) Mark Baigent; (bottom right) Leigh Simpson

Dublin goes passive: city set to make passive house mandatory

Irish local authority Dublin City Council has passed a motion so that new buildings in the city must be constructed to the passive house standard. The measure was agreed at a council meeting on 5 May to discuss the drafting of the new Dublin City Development Plan for 2016-2022.

The wording of the motion, which had been prepared by Passive House Plus editor Jeff Colley and was proposed by the Green Party group of councillors, states that: "Unless exceptional circumstances apply, the council will require new buildings to reach the passive house standard or equivalent, with the exception of buildings that are exempted from BER ratings as defined by SEAI. By equivalent we mean approaches supported by robust evidence (such as monitoring studies) to demonstrate their efficacy, with particular regard to indoor air quality, energy performance, and the prevention of surface/interstitial condensation."

The policy will now be included in a draft of the development plan due to be brought before the council in July, before a public consultation period begins in September.

The move follows a proposal by another Dublin-based local authority – Dún Laoghaire-Rathdown County Council – to make passive house mandatory in its draft count development plan for 2016-2022, which recently passed a public consultation deadline. The council has identified a need based on changing demographics for the construction of approximately 30,000 new homes within the lifespan of the plan.

News

UK Passivhaus Conference open to public for the first time

Photo: Philip Wade Photography

The Passivhaus Trust will host the fifth annual UK Passivhaus Conference on Tuesday, 20 October at the Business Design Centre in Islington, London. The event, run in partnership with the BRE, will be open to members of the public for the first time. The conference is expected to attract over 400 visitors and more than 30 exhibitors.

Hosted by Architype's Jonathan Hines, the conference will have a particular focus on passive house at scale in the UK. It will explore the biggest passive house projects currently under development in the UK, covering a total of almost 1000 units.

The conference also presents a great opportunity to meet some of the most exciting organisations at the forefront of delivering passive house projects in the UK. It will also offer a concentrated update of what has happened in the UK passive house movement over the past year.

The event will feature a mini trade show in the exhibition area, which will also include demonstration sessions for featured products. The trade show will also be open to non-conference attendees for the first time. The 2015 Passivhaus Award winners will also be on display, as will the finalists of the trust's student passive house competition.

The standard price of entry is £220 or £180 for PHT members (plus VAT), but a 10% early bird discount on this price is available until 31 August. There is also discounted entry of £50 available to students. You can book tickets online and find out more information at www.ukpassivhausconference.org.uk

(left) delegates at the sold out 2014 UK Passivhaus Conference

Potton on site with passive Cambridgeshire show house

Leading self-build timber frame company Potton, a subsidiary of Kingspan, is on site with a new passive house show home at their self build centre in Cambridgeshire.

Potton said that the contemporary look of the property takes the company, known for its more traditional designs, in a new direction. The new show house has been designed by HTA Design, and Potton has been working closely with the HTA team and passive house consultants Warm on the project.

"We are delighted to be part of this project with Potton and we very much look forward to the completion of this visually exciting and technically challenging sustainable design," said Rory Bergin of HTA Design. Potton's technical director Paul Newman added: "We wanted to show customers first hand that passive house buildings are wonderful places to live in and we wanted to dispel myths that the passive house design has to be boring and boxy."

The design incorporates a generous and flexible internal courtyard which creates room for reading, relaxation or entertaining. The show centre based in Mill Lane, Little Paxton welcomes over 5,000 visitors per year and attracts aspiring self-builders from around the country.

Potton's Self Build Show Centre features four show homes and an information centre which provides advice and design ideas on self build, with special themed events running throughout the year. Potton also run regular free self-build seminars for people getting started, titled An Introduction to Self Build, which aims to help people understand the steps involved in building with Potton.

The construction of Potton's passive show house – which will be constructed using the Kingspan TEK build system – will be accompanied by an extended exhibition programme branded 'Self Build Live', which will allow would be self-builders and existing customers access to visit and experience a live build. Visit www.selfbuildlive.com for more information.

(above) A rendering of Potton's passive show house, which is currently on site

News

Saint Gobain running passive house tradesperson course this October

Saint-Gobain UK & Ireland will be holding a passive house tradesperson course in October, enabling tradespeople to gain international accreditation for one of the world's most efficient energy standards.

The course will allow UK tradespeople to meet the growing demand for passive standard buildings, as more than 1,000 are expected to be built in the UK this year – a one hundredfold increase in just five years.

Delivered by experienced personnel from the Passive House Academy in partnership with Saint-Gobain, the course will run from 19-23 October and will be hosted at the passive house workshop in Saint-Gobain's Technical Academy in Erith, Kent.

With a combination of classroom lectures and presentations and a significant amount of time spent on practical hands-on training over a duration of five days, attendees will gain an in-depth understanding of passive house principles and learn specific techniques such as detailing correct airtightness testing and treatment, interpreting data from the Passive House Planning Package (PHPP), and outlining the building methods to avoid thermal bridging.

Stacey Temprell, residential sector director for Saint-Gobain UK and Ireland, said: "The course has been developed to offer tradespeople vital skills and knowledge of passive house construction to help the UK meet the growing demand for passive house buildings. More than 1000 buildings are expected to be constructed to meet the passive house standard in the UK this year, compared to just 10 units in 2010, and the course will help tradespeople gain a competitive advantage by becoming a qualified, accredited contractor."

"What makes the passive house course so unique is the focus on practical, hands-on elements enabling sub-contractors, consultants and architects to gain the necessary skills and professional development to achieve the passive house standard on site."

On completion of the course, participants will sit an exam to receive international accreditation from the Passive House Institute as a certified passive house tradesperson.

For more information and to book your place, visit www.saint-gobain.co.uk/products-and-solutions/passivhaus-tradesperson-course.aspx

(above) Practical work at a recent Saint Gobain passive house tradesperson course

Profico bring two passive house windows to the UK

New Croydon-based window company Profico is now supplying passive house certified Trocal and Inoutic windows to the UK market. "We mainly concentrate on very high energy efficiency windows and triple-glazing," Emil Rangelov of Profico told Passive House Plus. The company specialises in uPVC windows, and uPVC windows with aluminium cladding, but will soon be adding timber and timber/alumnium windows to its product range.

Profico currently supplies two Passive House Institute certified windows. The Trocal 88+ uPVC window features an 88mm thick profile and has an overall U-value of 0.8, according to its passive house cert. It comes with a 10 year guarantee and is also available with aluminium cladding that is available in every RAL colour.

Profico also supplies the Intouic Eforte, which can deliver overall window U-values as low 0.64, again with an optional aluminium frame available in every RAL colour. Floor to ceiling height of the window elements up to 2.6 m are possible thanks to the Inoutic bonding technology. Both of these passive house windows come with argon fill as standard.

"We work with high quality profiles from German manufacturers Trocal and Thyssen/Inoutic, and the hardware manufacturers Maco, Roto, Siegenia and Winkhaus to meet the highest standards in quality, durability and energy efficiency," Rangelov said.

Profico also supplies a range of other double and triple-glazed uPVC windows, as well as sliding, tilt and side doors, patio doors and entrance doors. The company provides a full supply and installation service, and Emil Rangelov told Passive House Plus this leads to better quality of workmanship.

"It definitely does, because we can get feedback straight from the customer, and we can inspect our own work and improve it if necessary," he said. For more information see www.profico.co.uk

(right) The Trocal 88+ passive house window, available in the UK via Profico

News

Ancon awarded BBA approval for insulating wall tie

Ancon has been awarded BBA Certification for its Teplo-L-Tie basalt-fibre low thermal conductivity wall tie. The certificate was presented to Ancon marketing manager Annabelle Wilson, by BBA's head of client accounts, Gary Dicker, at the 2015 Ecobuild exhibition in London.

The BBA's widely recognised third party approval follows thorough analysis of the Ancon Teplo-L-Tie's independent strength and durability test data, and its robust manufacturing controls.

"BBA product approval provides additional re-assurance to users, specifiers, building control, local authorities and insurers as to the quality and suitability of the innovative basalt-fibre TeploTie range, which is outside standard wall tie CE marking legislation," says Ancon's Annabelle Wilson.

Like the original BBA-approved TeploTie cavity wall tie, launched in 2009, the new Teplo-L-Tie comprises a pultruded basalt fibre body set in a resin matrix. This material, with its thermal conductivity of just 0.7 W/mK, minimises heat loss across an insulated wall cavity, which is an essential consideration in low energy construction.

Unique to the new Ancon Teplo-L-Tie, however, is an 'L' shaped stainless steel upstand, mechanically and chemically bonded to one end, which allows it to be securely tied to steel, timber, concrete or masonry using a range of standard fixings. Available to suit cavity widths up to 300mm, "It's ideal for today's super-insulated building envelopes, whether new build or refurbishment," Wilson said.

(left) The BBA's Gary Dicker presents product certification to Annabelle Wilson of Ancon

Ecological Building Systems launch Elka Strong Board

Ecological Building Systems has introduced an "innovative" new wood particle board, Elka Strong Board, to Ireland and the UK. Elka Strong Board is a high performance, diffusion open, structural wood particle board. It is suitable for external or internal application. The board is intended for use in load-bearing structural elements in humid conditions, and categorised as a P5 racking board in accordance with EN 312. It is produced by German manufacturer Elka-Holzwerke.

Elka Strong Boards were successfully introduced to the German timber and building materials trade in 2009. "The boards have considerably less risk of swelling compared to OSB3, a critical property in our humid climate," said Ecological Building Systems senior engineer Niall Crosson. "They also feature superior transverse tensile strength compared to OSB3 (approximately 40% more). This ensures superior screw and nail extraction properties. The bending strength and modulus of elasticity of ESB boards are the same in both directions, unlike OSB panels where the value is halved across the width. This in turn greatly simplifies the installation process and minimise errors on site."

The boards may be applied internally or externally, and are compatible with diffusion open breathable

wall and roof structures. With a μ value of only 24, Crosson said that Elka Strong Boards are over six times more diffusion open than many OSB3 boards. "This in turn significantly increases the ability for walls and roofs to dry out in the event of unforeseen moisture entry. Due to the board's exceptional low vapour resistance, they may be used as an internal racking board in conjunction with intelligent vapour checks, such as Intello Plus, without inhibiting the performance of the membrane from a vapour diffusion perspective."

As the boards utilise exclusively virgin green wood chips from a neighbouring sawmill, minimal processing is required. "This in turn ensures the boards are practically odourless due to their low VOC emissions, which in turn contributes to a healthy indoor climate," Crosson said.

The board may also be applied internally as a surface finish, and has a sanded and virtually sealed surface, enabling water-vapour-permeable varnishes, paints and adhesives to be directly applied. The wood required to manufacture Elka Strong Board is sourced from sustainably managed forests and the boards are PEFC, and CE certified. More information regarding Elka Strong Boards may be viewed on www.ecologicalbuildingsystems.com

(left) Elka Strong Board, available in the Ireland and UK via Ecological Building Systems

News

Prefabrication key for upscaling passive house — de Bruycker

Leading passive house architect and builder Bram de Bruycker has said that prefabrication is crucial to upscaling of the passive house standard. De Bruycker has vast experience of building homes, schools, offices and public buildings to the passive house standard, and currently serves as technical director of London-based passive house design-and-build business Princedale Homes.

Princedale Homes and passive house window and timber frame supplier GreenSteps have recently joined forces to launch Naked House, a new totally prefabricated passive house timber frame system, with windows and first fix installed off site. In an article published on the Passive House Plus website, de Bruycker emphasises why he believes prefabrication is so important for delivering the quality of passive house at scale.

"In the clean covered environment of a production hall, it is possible to work in shifts and produce more houses, but also to deliver a perfect product with quality control that gives the end user a guarantee the system will deliver what it's built for," he writes.

He adds that, in his view, building a timber frame passive house entirely on site from pre-cut timber is labour intensive, has a higher risk of errors, and requires intensive training of everyone on site. He also writes that while prefabricating an open panel system and insulating it on site is better for quality control, it is still inefficient as lorries transport empty panels, and the frame is still left exposed to wind and rain on site.

In the blog post, he advocates for a "highly engineered prefabricated panel system" in which as many building elements as possible — inner and outer boards, insulation, wind and weather membrane, airtight layer and even windows and outside cladding materials — are installed in the factory.

He continues: "My experience has taught me that the future of construction is the fully prefabricated system where the dry environment of manufacturing gives you the opportunity to have an efficient quality control system, and a 100% success rate in delivering a draught-proof building envelope."

You can read the full blog post at: www.passivehouseplus.ie, and find out more information about Naked House at: www.nakedhouse.co.uk

(above) The GreenSteps timber frame factory in Latvia, where pre-fabricated panels are produced, including pre-installed first fix plumbing, electrical ducting and windows

Target Zero to train builders in passive house in China

Leading passive house training centre and consultancy Target Zero has agreed a new collaboration with a Bejing-based company to provide a course in passive house construction in the Chinese capital this June.

It is just the latest in a series of exciting developments for Target Zero, the company's Darren O'Gorman told Passive House Plus.

O'Gorman also said that the company is currently on site with a number of projects that are nearing completion, including an Enerphit in Rathgar, Dublin by Pat Doran Construction, 13 passive sheltered housing units in Baldoyle, Dublin for Cowper Care, and a new build house in Cheshire by IGG group that is aiming for the newly announced passive house premium certification class – meaning the building will not only be a passive house, but a genuinely net zero energy user.

Target Zero runs regular passive house designer and passive house tradesperson course at its own training centre at the Institute of Technology, Carlow, at the Centre of Refurbishment Excellence in Stoke-On-Trent, and in London. For course details and dates visit www.targetzero.ie

The company also provides passive house consultancy. "I have noticed a substantial increase in requests for PHPP assessments for new builds both in the UK and Ireland recently," O'Gorman said.

He added that in response to strong demand for in-company passive house training in the UK & Ireland, Target Zero also offers tailored theory and practical training with flexible dates and affordable rates. Clients this year have include MBC Timber Frame, RG Carter, Grosvenor UK, and Clioma House.

News

Passive House Association of Ireland to host two See the Light conferences

The Passive House Association of Ireland (PHAI) will run two See the Light conferences this year, one in Enniskillen, Co Fermanagh and one in Cork.

The conference has traditionally been a once-off annual event in Dublin, but the focus this year is on bringing it to other parts of the country.

The first conference takes place at the passive house certified Crest Centre in Enniskillen – as featured in this issue of Passive House Plus – on Thursday 24 September.

"This is the first time the Passive House Association of Ireland is holding its announce conference in a passive house building," the group's chairperson Shane Colclough told Passive House Plus.

The Enniskillen conference will coincide with the formation of the Northern Ireland chapter of the PHAI.

Meanwhile a second See The Light conference will take place in Cork on Friday 13 November. This will precede the Passive House Days event on the Saturday and Sunday, at which participants will be able to visit passive house buildings.

The PHAI is also running another student design charrette this year, following the success of last year's event in University College Dublin. Following their victory in last year's competition, Waterford IT will play host this year on Friday 16 October. The charrette challenges students to come up with a building design based on passive house principles in a short period of time.

(above) Passive house conference in a passive house: The Centre for Renewable Energy & Sustainable Technologies in Enniskillen will host the Passive House Association of Ireland's See the Light conference on 24 September

MVHR beats air con for comfort & cooling — Zehnder

In hot conditions air conditioning may be insufficient for keeping indoor temperatures cool and comfortable, according to leading ventilation experts Zehnder. This is because as well as actual temperature, humidity also plays a key role in how we perceive temperature. Zehnder is a leading manufacturer of passive house certified mechanical ventilation with heat recovery (MVHR) systems.

"Imagine getting into your car on a hot summer's day after it has been sat baking in the sun. You open the door and feel the heat hit you and your immediate reaction is to ramp the air conditioning thermostat down to low and the fans up to high," said Michelle Sharp, communications manager at Zehnder Group UK. "For a few minutes it's sheer bliss. However, once the air temperature has reduced to low, normally 16C, our ideal comfort level has been surpassed and the rest of the journey is spent alternating between turning the air conditioning on and off, never quite reaching a comfortable level."

"The same is true of our homes during warm spells of weather," she said. Sharp added that three major factors can combine to cause overheating in buildings: our ever more energy efficient buildings, climate change, and increased urbanisation, with the associated urban heat island effect. She added that thermal comfort is particularly important at night.

CIBSE's Guide A: Environmental Design advises that bedrooms should be 23C or lower for quality sleep. Meanwhile research carried out by CIBSE and Arup tells us that 3C is enough to turn us from comfortably 'warm' at 25C to uncomfortably 'hot' at 28C.

"In order to achieve comfort in homes, we also need to pay particular attention to the effect of humidity on perceived versus actual temperature — the additional 3C may just be perceived heat due to humidity levels," she added.

"Specifying air conditioning systems really won't help achieve true year round comfort in residential dwellings," she said. "By reducing the humidity levels in the home you can also reduce the perceived air temperature and add to the comfort of the occupants. The added benefit being that it will be felt throughout the entire home with none of the draughts or increased energy usage associated with other cooling methods. Specifying an alternative comfort cooling technology alongside your ventilation strategy means that you can get it right first time, and maintain comfort throughout the year."

To discover more about overheating in modern homes, a copy of Zehnder's eBook Comfort, Health & Indoor Air Quality is available to download at Zehnder's passive house website www.zehnderpassivehouse.co.uk

(left) Michelle Sharp, communications manager at Zehnder Group UK

News

Alsecco EWI chosen for Exeter passive house scheme

Gale & Snowden Architects have specified Alsecco's Basic 1 external wall insulation system for the construction of 14 passive house units in Exeter. Following on from the success and lessons learnt on a previous scheme, Exeter City Council commissioned the architects, who are Passivhaus Trust members, for this project.

The developments of Brookway and Bennett Square form part of an on-going strategy to build more council homes to address fuel poverty in the area. The properties have been built on infill sites, making use of areas of land not presently being utilised.

Alsecco's Basic 1 external wall insulation system was specified, and incorporated 250mm of grey expanded polystyrene above the DPC, with 250mm of extruded polystyrene below. The EWI system was installed to the exterior of the medium density blockwork construction, eliminating the danger of interstitial condensation and thermal bridging, since the insulation is on the outside with the thermal mass of the blockwork retained inside.

Specialist EWI installer PRS Group installed the EWI system with a Silitect top coat finish in three shades of red on some properties and cream on the others, making for a striking visual appearance of the blocks as a whole. A particular design and environmental feature of the project was the installation of 15kg bat boxes to the gable ends of the blocks. Alsecco identified that standard fixings could not be used to install the boxes, as it was essential to avoid cold bridging, therefore the boxes were installed using the Dosteba fixing method.

Built by main contractor Interserve, the new homes will be let to families in need of housing, with three of the new properties having full wheelchair access. The properties also incorporate further energy efficiency measures to achieve the passive house standard, including triple-glazed windows to complete the insulation of the envelope, and mechanical ventilation with heat recovery.

Alsecco's EWI system was chosen for Exeter City Council's latest passive house schemes in Brookway (pictured) and Bennett Square

JG Speedfit picks up awards & launches wireless TRV

JG Speedfit has picked up two Wolseley Supplier of the Year awards for the second year running, one from Plumb Centre (pipes, valves and fitting) and from BCG Distribution, two of Wolesley's sub brands.

Wolseley is the world's largest trade distributor of plumbing and heating products and a leading supplier of building materials. JG Speedfit's director of UK sales, Mike Riseley, picked up the awards in February at the Wolseley Supplier conference earlier this year.

"It is humbling to be recognised for our achievements, however it must be said that it is a collaborative approach to our business relationships that make these awards possible," Mike Riseley said. "I would offer my sincerest gratitude to all the individuals from both Wolseley and John Guest Speedfit who have played a role in our mutual success."

JG Speedfit has also announced the launch of a new wireless thermostatic radiator valve, the JG Aura TRV, which is available to purchase from 1 July 2015.

The valve has been designed to efficiently regulate the hot water to each radiator in the house. The new valves are controlled wirelessly by a JG Aura thermostat in every room, and can send a signal to the JG Aura network that would then turn the boiler off when a desired room temperature has been reached.

JG Speedfit also recently launched a new website at www.speedfit.co.uk that is designed to give a visual focus to the functionalities of the brand's product ranges. The website features videos of best installation practices, technical advice and product specifications.

JG Speedfit is an easy to use, plastic push-fit system suitable for the plumbing of hot and cold water services and heating applications, from leading plumbing manufacturer John Guest. The flexible piping system is designed to significantly reduce installation time without the need for specialist tools.

(right) the JG Aura TRV, JG Speedfit's new wireless thermostatic radiator valve

News

Ecological picks up award for fabric first course

Photo: Chris Bellew/Fennell Photography

Ecological Building Systems picked up a Product of the Show award in the Best Services Provider category at this year's SEAI Energy Show in Dublin. The company won the award for its 'Better Building: Putting the Fabric First' course.

"Training specifiers, energy consultants, builders and homeowners has always been the cornerstone of Ecological Building Systems services since our inception almost 15 years ago," said Ecological Building systems' senior engineer Niall Crosson.

"The company does not solely supply insulation and airtightness products of the highest quality. We also provide unsurpassed training and back up. With our extensive knowledge in regard to high performance, healthy construction – using natural materials – we are in a unique position to impart our knowledge to all those involved in the construction industry. Therefore it was a great honour to receive such recognition for the training and services we provide from the Sustainable Energy Authority of Ireland."

Crosson continued: "While renewable energy is to be fully supported, the basic foundation of any low energy building, be it new build or retrofit, is to focus on the fabric. Airtightness, thermal continuity, ventilation and using more natural materials which contribute to a heathy living space are core components of the training we provide."

The Better Building course also introduces attendees to the basic principles of passive house buildings, and how to comply with the latest iteration of Part L of the building regulations. Training is provided by Crosson in conjunction with Roman Syzpura of Clioma House Ltd, who runs the highly skilled practical sessions. More details about the course can be found at www.ecologicalbuildingsystems.com

Ecological Building Systems showcased Gutex woodfibre insulation, the Pro Clima intelligent airtightness system and other natural insulation materials and solutions at this year's Energy Show in the RDS, Dublin on March 25 and 26.

The show, SEAI's annual business-to-business event, hosted over 170 exhibitors along with multiple networking events, an extensive electric vehicle showcase, live retrofit demonstrations, an international markets pavilion and a wide range of workshops.

(above) Niall Crosson of Ecological Building Systems receiving the company's Product of the Show Award 2015 from (left) Brian Scannell, one of the judges, and (right) Tom Halpin, head of information at SEAI

Beam launch new MVHR controller technology

Homeowners may be unaware of how their mechanical ventilation with heat recovery (MVHR) system is performing if the unit is in an out-of-reach location, such as a loft.

So to give homeowners more control over their MVHR system, Beam Vacuum & Ventilation has launched Aurastat, an advanced remote programmable controller and display which is connected to Beam's C Range of MVHR systems via a wired connection, and is typically located in a central location.

Beam's sales manager, Paula Osborne said: "We're pleased to introduce Aurastat, an exclusive control and display panel for our Axco C Range of MVHR systems. The display monitor is located within the habitable property and indicates system performance information such as filter change, boost speed, summer bypass, fan speed, digital humidity control, fault alerts etc.

"Such information allows for greater flexibility and user interaction, whilst complying with new NHBC best practice guidance."

Osborne added that Beam strive to stay at the forefront of innovation and set new standards in the creation of healthy, energy efficient homes. For further information visit www.beamcentralsystems.com

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Other (please state): ______________________

Floor area (approx. ft² or m²): ______________________

Budget (approximate): ______________________

Stage (tick box)

Initial appraisal ☐ Pre planning ☐ Planning approved ☐ Pre tender ☐
Commencement notice ☐

Project imperatives (tick box)

Certified passive ☐ Near passive/low energy ☐ Indoor air quality ☐ Low running costs ☐
Low environmental impact ☐

Other (please state): ______________________

Estimated start date (please state): ______________________

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The UK's journey to zero carbon homes – are we there yet?

*Irish building regulations used to look a lot like the UK versions, but a divergence in recent years has seen Ireland aiming for dramatic 60% energy and carbon reductions for new homes, and the UK only setting its more modest improvements in terms of carbon emissions reductions. As the UK's pledge that all new homes will be "zero carbon" by 2016 draws close, **Dr Neil Cutland**, director of Cutland Consulting Limited gives his view on the road ahead – including a possible role for passive house.*

The journey so far

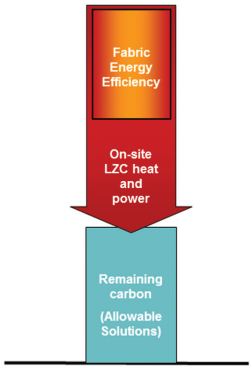
I've been closely involved with the passive house movement ever since we brought it into the UK in 2006, and I sat on the board of the Passivhaus Trust for several years. I'm a great advocate for the passive house principles and standards, and – some would say controversially - I'm passionate about trying to make it fit with the UK government's zero carbon homes policy. But given how many times the definition of zero carbon has changed, that could be quite a task.

Until 2008 the UK housebuilding industry was faced with a definition of zero carbon which effectively required all carbon dioxide emissions, both 'regulated' (those arising from heating, cooling, ventilation and lighting) and 'unregulated' (those due to household appliances), to be reduced to zero though on-site means. The early work that we did though various task groups concluded that there were going to be some sites, especially small ones, heavily constrained ones and sites with lots of flats, where you wouldn't be able to execute a 'pure' on-site zero carbon strategy, so it was pragmatic that we figured out a mechanism through which mainstream housing could deal with the last bit of carbon.

"The passive house QA procedures provide a ready-made & technically robust way of achieving as-built compliance with building regulations."

During 2009 the concept of 'allowable solutions' was therefore proposed, whereby fewer emissions would have to be eliminated by on-site means and an approved list of carbon-saving measures would be available to mitigate the remaining emissions.[1]

The definition has for several years been represented diagrammatically by an upward-pointing triangle, which UK readers will be familiar with. I've always preferred the following graphic, which explains more clearly exactly what you have to do in order to meet the definition:



The legislation will contain a requirement that allowable solutions (in blue) can only kick in once the on-site fabric and services measures (in red/orange) have reduced the emissions to a certain level. In this instance I'm content that allowable solutions are not a cop-out. In practice, most developers will choose to make a cash payment to an allowable solutions provider, who will take the responsibility and liability for implementing carbon-saving projects elsewhere which deliver the same amount of emissions reductions. Of course, the payments must be ring-fenced and the mechanism properly policed.

Where to now?

The following three issues are occupying my thoughts right now:

1. All change, yet again. Just days before parliament was dissolved in March 2015 for the general election, the Infrastructure Act was granted royal assent. During the preceding debate, the government made it quite clear that it intends to backtrack on the allowable solutions kick-in level, relaxing it by as much as 25% over the previously agreed level. That previous level had been carefully formulated by collaborative working groups in 2009-2013, the groups having reached a consensus which satisfied the national housebuilders, consumer representatives and green enthusiasts alike. (As a rather intriguing aside, the new level is going to be set in terms of the Code for Sustainable Homes – which, according to a written ministerial statement issued on the same day, has quite categorically been abolished!)

2. Different flavours of zero. In the coming years, the way in which individual housebuilders achieve zero carbon will be contentious. One home may be built with on-site technologies that ensure that it is fully zero carbon at the point of use, while another may be built to a lower standard on site but will make use of allowable solutions. Both homes will be legitimately zero carbon. But in the former case the residents' energy bills will be low or even negative, while the people living in the other home are going to have very real fuel bills. That's going to be hard to explain, and will present a significant marketing challenge to the housebuilders.

3. Resistance is futile. We passive house enthusiasts will never win the argument that our privately-run, voluntary standard – however good it is – should replace the national building regulations. That notion is simply a step too far for the ministers and civil servants. We should instead make the case to government and industry that our proprietary standard is a guaranteed and cost-effective way of achieving compliance with the building regulations that we end up with. I also believe that the debate about the accuracy of the UK's national calculation methodology, the long-running 'Sap versus Passive House Planning Package' battle, is an unhelpful red herring. It's time to move on. We should focus instead on the 'design versus as-built' battle. The housebuilding industry agreed to the principle of as-built compliance during working groups in 2010-2011, so the government does not need to backtrack. For reasons of political expediency, the passive house community should now say "Actually, SAP is pretty much OK", and go on to make a really convincing case that the passive house QA procedures provide, for the market and for government, a ready-made and technically robust way of achieving as-built compliance with building regulations.

For further information contact neil@cutlandconsulting.co.uk

[1] A further re-definition occurred in 2011, when unregulated emissions were excluded from the definition altogether.

It's a myth that passive houses cost a premium to build

Passive houses can be built at surprisingly competitive costs – argues ***Larry O'Donoghue****, director of low energy builders Magner Homes – and he has the data to prove it.*

As interest in the passive house standard grows, we are being asked more frequently to price not just for Part L compliance or an A2 BER, but for passive house. Many clients are interested to see how much extra it would cost to go certified passive, safe in the assumption that it will cost so much more that it won't warrant serious consideration.

We are finding recently that there is more or less no difference in the cost to go certified passive. This comes as a shock/pleasant surprise to clients because certified passive is seen as a premium product. But with several recent improvements in the building regulations it was inevitable that the gap between regulatory compliance and passive would lessen – or even close completely.

Our experience from real projects is that uncertified passive houses can be built for €80 to €100 per sq ft. The cost data on four such projects we've completed recently is revealing:

Project	House type	Finish specification	Cost	Area (sq m/ sq ft)	Cost per sq m/sq ft
Watergrasshill	Dormer	Stove fit, plumbed vacuum, wood floor supply	€220,500	238/2562	€926/€86
Castlemagner	Two storey	Builder's finish	€247,000	278/2992	€888/€83
Waterfall	Two storey	Turnkey	€309,800	289/3111	€1072/€100
Blarney	Two storey	Builder's finish	€231,543	280/3014	€827/€77

These figures are rough and ready, and while there are lots of caveats, the overall picture is good. None of these houses were designed with the aid of PHPP but were run through it after the fact. Had PHPP been used from the outset, the houses may have achieved lower surface area to volume ratios – planners permitting – as it's easier to hit the passive house standard with more compact forms. That means less spent not just on insulation, but on all materials. Also, potential savings were not always taken on board. For instance, heat pumps were installed even though not needed to meet the passive house standard. Some of these costs also include domestic wells and wastewater treatment plants, which wouldn't be applicable in an urban environment. The main specifications on our typical passive house projects are:

- Base – thermally broken strip foundation
- Floor – 300 EPS
- External walls – 250mm cavity with 250mm bead insulation and basalt wall ties
- Attic – 400mm Metac
- Airtightness target - < 0.6 ACH
- Windows – passive certified UPVC
- Passive certified mechanical heat recovery ventilation
- Wood pellet stove with six to eight radiators throughout the house
- Thermal bridge values of < 0.08 PSI

We are currently working on a number of passive houses that will be submitted for certification, and this will entail some additional costs, taking into account consultancy, thermal bridge calculation and certification, of roughly €4000.

There are, however, a few considerations.

1) Heating system: There is somewhat of a leap of faith needed by the client in terms of removing the heat pump and underfloor heating from the specification and using the saving to upgrade the envelope and pay for the passive certification.
2) Added to this, unless the primary heating system is renewable based such as a wood chip burner, there may be issues with Part L compliance. It would be perfectly acceptable in PHPP to install a small gas boiler as the primary heating system but you can kiss goodbye to Part L compliance in that case.

So what are the top tips for building low cost certified passive homes?

1) Thermally broken foundation: We have built several houses with variants of the insulated foundation. These perform incredibly well but the premium cost can be anywhere from €6-€10,000. We have found through PHPP that a well-designed thermally broken strip foundation will achieve the required standard for a fraction of the cost.
2) Super wide cavities: When we initially started to build masonry passive houses we were drawn to the block on flat with external insulation. There's no doubt it is a great system, but it's relatively costly. When the basalt wall ties achieved certification for super wide cavities we moved over to this system. It can achieve the required U-values and thermal bridge coefficients for a marginal increase over traditional cavity wall layups. We're big fans.
3) Windows: If you want performance and value it's difficult to look past the various passive certified UPVC products (I can hear every architect in the country moaning as I type). Aluminium clad products will come at a premium for the aesthetics with no improvement in energy performance.
4) Dial back on heating systems: The whole point of certified passive is that the house will maintain a constant 20C without the need for a primary heating system. So it calls into question the logic behind installing an expensive heating and distribution system. Technically a stove is plenty but it's nice to have a backup so perhaps a small wood chip /gas/oil burner linked to a few radiators would suffice. Alternatively you can forgo the stove, boiler and chimney, and use the savings to pay for an air-to-water or air-to-air heat pump.
5) Certify: We speak to a lot of clients and often hear that they want to build a passive house but don't necessarily want to certify. This in our view is a missed opportunity. Without certification you have no real idea how the house will perform. Passive is all about the finer details and winning in the margins. The quality assurance that comes with certification is critical.
6) Plan airtightness: Achieving the passive airtightness target is no mean feat. Carefully plan the strategy for getting services into and out of the building. Introduce service cavities instead of chasing external walls. Don't just hope for the best, test before closing up the building. If you are using a specialist contractor to carry out this work, involve them during the construction drawing stage and make sure they have a track record in achieving the standard.

So we have reached a point where certified passive houses are no longer the preserve of the wealthy. With some clever specification choices and the right team on board it's achievable for highly competitive build costs. The benefits are enormous however – a healthier and more comfortable living environment, more consistent temperatures throughout the house and lower running costs for heating. The argument for not going passive is becoming difficult to make.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INTERNATIONAL SELECTION

This issue's international selection features a developer-built passive house in Philadelphia, a big new research centre in Frankfurt, a sleek family home in Vienna, and a new low-energy factory in Canada where passive timber buildings will be prefabricated.

BC Passive House Factory, Pemberton, British Columbia, Canada

BC Passive House is a manufacturing company that prefabricates passive timber-frame building systems. Completed in the summer of 2014, the company's new factory is an 'all wood' demonstration project designed to exemplify the firm's commitment to wood design and sustainable construction.

The building, designed by Hemsworth Architecture, consists of a large open workspace divided into two distinct bays used for manufacturing, plus a conference room and office mezzanine to the southwest, where 360-degree clerestory windows provide natural daylight and spectacular mountain views.

The mezzanine offices, support spaces and showroom were designed and built to meet the passive house standard, with space heating demand of 14Wh/m^2/yr. The building's envelope was constructed using BC Passive's wood-based, double wall, super insulated system that is airtight while remaining vapour diffusion open to the exterior. Blown cellulose recycled paper was used for insulation, and while a final airtightness test has yet to be completed, BC Passive House expect a result of around 0.3 air changes per hour.

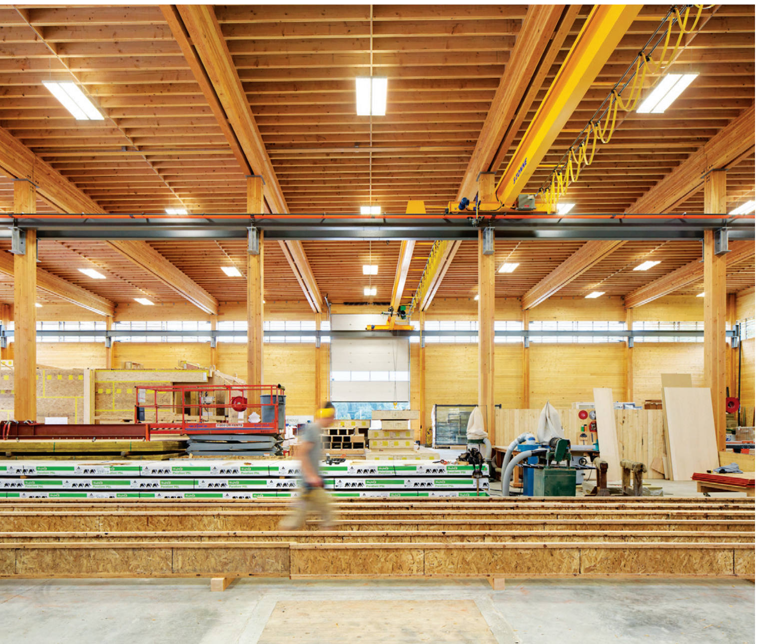
The open workspace has different heating requirements to offices, only needing temperatures of 10-15C. Here, a biomass boiler uses wood waste from manufacturing to deliver heat through an underfloor radiant system.

The use of these prefabricated structural components allowed for the building's superstructure to be set-up onsite in just eight days.

In addition, prefabrication allowed for the construction of the building components in a controlled environment — increasing efficiency, quality control and precision while reducing exposure to weather. The building's exterior was finished in fir and larch that was left untreated, with the intention that it grey with each passing season. This provides a natural, VOC free, no maintenance solution.

Products and materials were chosen for low environmental impact. The conference room was finished with cedar milled from trees salvaged from a 1930s burn site. Plant storage, desks, shelves and staircases were constructed from waste CLT panels, while pumice and recycled foam glass insulation were used for under-slab insulation. Adopting a wood first approach for the structure of the building also avoided approximately 365 metric tons of CO_2 emissions, according to the woodworks.org carbon calculator. ▸

Photos: Ema Peter Photography



Photos: Uwe Dettmar & Axel Stephan; AS&P – Albert Speer & Partner GmbH, Frankfurt/ Main

House of Logistics & Mobility, Frankfurt, Germany

In 2011, the Holm, an interdisciplinary research centre working in the logistics and mobility sectors, tendered for the construction of a new research centre in the Gateway Gardens district near Frankfurt Airport, which AS & P — Albert Speer & Partners — won together with project developers Lang & Cie Real Estate AG.

Now completed, this passive-certified building is seven-storeys high, with two more floors underground. Shaped like a figure of eight, the building's architecture is designed to support the networking and open exchange of ideas between its users. The design features a bright seven-storey atrium, at the heart of which is a flight of stairs dubbed the 'X-Celerator', which forms the centrepiece of the building.

Meanwhile the walls are constructed from externally-insulated precast concrete with a ventilated facade, while the roof is built from reinforced concrete too. The building is hooked up to the local district's combined heat and power network, which supplies heat via low-temperature ceiling panels.

With passive house design by Lenz Weber Engineers, the building's vital stats tick all of the right boxes: airtightness of 0.27 air changes per hour, space heating demand of 14kWh/m^2/yr and primary energy demand of 115 kWh/m^2/yr. And as well as passive house certification, the building also boasts a 'silver' certification under the German DGNB scheme. And we think it looks pretty damn good, too. ▸





Passive house, Gerasdorf, Vienna, Austria

This passive-certified family home in Gerasdorf, just outside of Vienna, is the second project we've featured by leading Austrian passive house architect Thomas Abendroth. This contemporary house's walls are constructed from poroton fired-clay blocks with 400mm of polystyrene insulation externally, while the roof is insulated with polystyrene too. The dwelling also features triple-glazed Internorm windows.

The house's southerly orientation is ideal for passive solar gain, while there is no glazing whatsoever on the north facade. Meanwhile a timber screen helps to shield the house from the street, and encloses the private roof terrace too.

The house has a Drexel & Weiss compact Aerosmart unit that provides heat recovery ventilation, and domestic hot water via a micro heat pump. There's also a heat exchanger buried in the ground that pre-heats incoming fresh air using the earth's nature heat, before the air is pumped into the house.

This 281 square metre house has a space heating demand of 15kWh/m^{2}yr, heat load of 9.5 W/m^2, and airtightness of 0.3 air changes per hour. These might be fairly standard specs for a passive house today, but this house is nine years old now — meaning it was quite ahead of its time when it was built in 2006. ▸

Photos: Andreas Buchberger, Vienna

Fishtown passive house, Philadelphia, USA

This speculative passive house was developed on a long-vacant lot in a Philadelphia neighbourhood undergoing a flurry of construction at varying scales and standards of quality. With so much new construction on the market, the challenge was to significantly raise the quality of construction without pricing the home out of the neighbourhood.

To maintain an aggressive sales price of $325,000 for this 2,000 square foot, three-bedroom home, designers Re:Vision Architecture and builder/developer Mark Hutchinson of Archetype Properties (also a passive house consultant) put a lot of emphasis on keeping construction details simple. Costs were shaved by sharing one set of supply ducts for both the Goodman mini-split heat pump and the Zehnder heat recovery ventilation system.

The house features double-stud walls with Roxul mineral wool insulation, plywood sheathing sealed with ProClima airtight tapes and vapour control membrane, triple-glazed Intus uPVC windows, and a 2.5kW solar PV array — which all contribute to making it net-zero energy for core operations. The solar system was installed by the developer and a carpenter in a single day using the simple Renusol solar PV mounting system.

Photos: Juergen Lunkwitz

Despite the cost-conscious design, some key details were incorporated to make the home feel vibrant and inviting, such as a central open staircase, deep windows suitable for plants, an insulated basement, and windows raised five feet above the ground floor so the residents can see out and be connected to the street, but not require window shades for privacy.

The passive house details were a key factor in the quick sale. In fact, the buyers included a clause in the sales contract that the home must achieve airtightness of 0.6 air changes per hour. Thankfully the final blower door test result came in at 0.5, and the house was certified by the New York office of Ireland's Passive House Academy. This all electric home is extremely comfortable year-round, with total utility bills averaging just $50 per month.

Want to know more?

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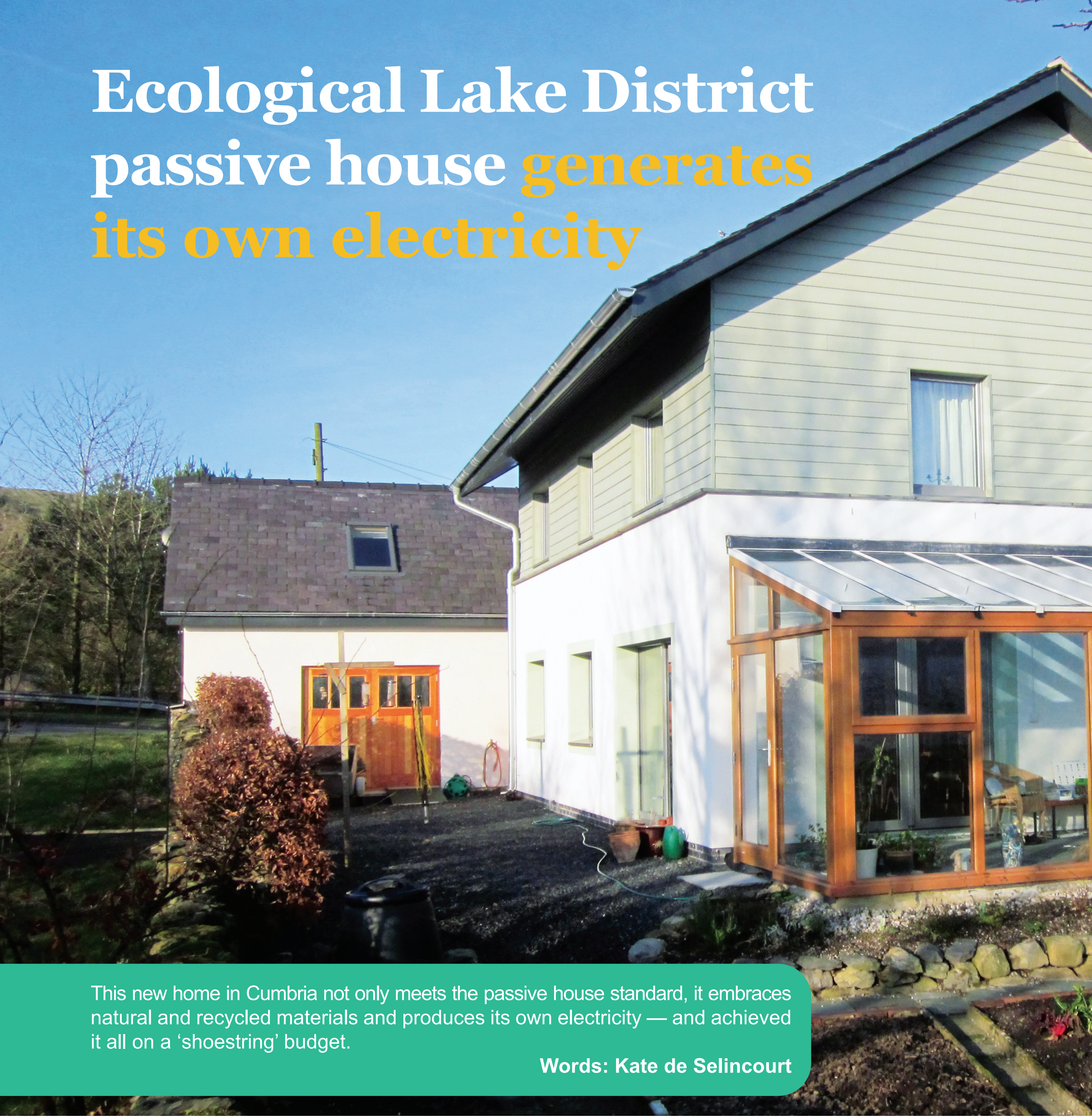
Ecological Lake District passive house generates its own electricity



This new home in Cumbria not only meets the passive house standard, it embraces natural and recycled materials and produces its own electricity — and achieved it all on a 'shoestring' budget.

Words: Kate de Selincourt

Back in the 1980s, it's fair to say that British homes, old or new, were a bit on the cold side. But one young couple got a glimpse of the future when some family members imported a Swedish kit house. They were struck by how quickly it went up. It was properly insulated, had triple-glazed windows, and was warm. They were hooked on the idea of building something similar for themselves.

Fast forward to 2012, and a move to a village in the gorgeous Cumbrian fells finally gave the couple (who wish to remain private for this article) an opportunity to make that dream a reality, when they were able to buy a plot in the village they had chosen as their new home.

In the intervening years they had kept themselves informed: as members of the Centre for Alternative Technology they followed the progress of low energy housing design in the UK and internationally. Airtightness emerged as an issue alongside high levels of insulation, and then the passive house standard came on to the scene.

Because of their long-standing interest in sustainable low energy building, passive house was the logical approach. And passive house architects EcoArc, led by Andrew Yeats, were based just down the road. The couple became the first of EcoArc's clients, after the Lancaster Co-Housing group, to move into a passive house. But EcoArc now have no fewer than 17 further passive projects in the pipeline.

The 41 homes at Lancaster were of masonry build, but this client chose to build with timber: "I'd done quite a bit of reading and knew there were plenty of timber-framed passive house builds, so we couldn't see any reason why not; and we really wanted a building that could go up and become weathertight quickly."

The client did some research and opted for a timber frame system delivered by Irish firm MBC. "We were looking for a firm who had an integrated system for floor slab and walls – as this is one of the trickiest junctions, it's important they work together properly. It may not necessarily be a problem if you have a worked-out design, but using a single system for both seemed to be useful to us – not least to avoid having two separate contractors blaming each other if it went wrong!"

Andrew Yeats initially had his reservations

about using timber frame for passive house, for example over the possible lack of thermal mass, but he's now a convert. "I'm now sold hook, line and sinker on timber frame. It's just so quick to put up. At Lancaster, we struggled all through the winter in the frost, rain and muck. Timber frame is so much more manageable, quicker and cleaner," he says.

Thermal mass has not proved to be a significant issue at the Cumbrian house – there is an insulated concrete slab under the reclaimed wooden floors, which provides mass. The wall system consisted of pre-constructed twin-stud panels, delivered to site to be taped then filled with pumped cellulose insulation.

The panels support the roof, allowing continuity of insulation and rapid weather-tightness. The frame was then sheathed with a rendered block wall around the ground floor and wooden cladding at first floor, both for aesthetic reasons and to create a clear cavity to ensure Cumbria's driving rain does not get into the insulated fabric.

The finished building is a neat, compact house with a simple form, that was cost-effective to build and is very easy to heat. "It's very comfortable, we had to get used to the even temperatures everywhere. There is no fire to sit next to, but it is very, very nice. Especially in cold weather, it's lovely — immediately you are in the warm. The indoor temperatures average around 21 or 22 degrees, and it has never gone below 18," the client says.

The very low heat load is evident: "It warms up very quickly in response to the number of people here, or when we are cooking. It's very efficient at keeping us warm."

Passive house is known for minimal heating systems, and this build was designed and built according to the classic approach of an electric heating element in the ventilation supply ducts. However, the occupants prefer to manage without any direct heating as far as possible. Instead, like all passive buildings the house makes good use of solar gains and internal gains from people and appliances, then on top of this there is an almost-all-renewable contribution from the giant 500 litre thermal store at the heart of the house. The thermal store – whose primary job is providing domestic hot water — receives most of its heat from renewables on the roof. ▸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The store is heated firstly by 7.8 square metres of solar thermal panels. If these are not keeping the tank hot enough, immersion heaters kick in, topping up the heat at times when the solar PV panels on the roof are generating electricity. If necessary, the immersion heater can also take advantage of 'Economy 7' low cost night-time grid electricity – but only between 2am and 6 am (and for the top of the tank only), just to ensure there is some hot water first thing in the morning.

This has worked well, with most of the heat coming from the renewables, throughout the year. With all that heat sitting on the landing, even though the store is insulated, enough passes out into the living space to keep the house warm too, with direct electric heating only being deployed occasionally.

The client says: "It's an all electric house, and although I haven't kept close track of the running costs, I estimate we are using slightly less electricity than we are generating, so we are in energy balance more or less. We do need to make some minor changes to the system, as at the moment there is no heat dump for the excess hot water in summer, which can lead to the house overheating. It's easy enough to deal with this by opening the windows, though."

They are happy with the MVHR too: "We find it very straightforward. It's extremely quiet, we like to ask our visitors if they can hear it, and they can't. It's tremendous – we're very happy with it."

Although this is only EcoArc's second completed passive house project, Andrew Yeats admits he is now "very evangelical" about the standard – clearly with some success, as a large proportion of his subsequent clients have also commissioned passive builds. "When clients come to me, I tell them this is what we do: there would have to be a very good reason not to do passive house."

One potential obstacle raised by EcoArc's clients is cost. Having delivered cost-effective masonry build passive houses for Lancaster Cohousing, Yeats was keen to demonstrate cost-effective passive house in timber frame as well – and believes he has succeeded.

His Lake District clients needed to build "on a shoestring" after buying quite an expensive plot (this, says the client, is why they have not had the house certified – they just didn't have the money left over).

The final build cost was £1370/m^2. "Some architects would struggle to do a regular home for that," Andrew Yeats points out. He believes this offers good value for a home that really performs. "After all, architects can be very good at spending other people's money on things that don't really mean anything!"

He continues: "We kept the costs down by the way we ran the contract. We have had terrible experiences with competitive tendering for passive house. Until they have enough confidence to price fairly for passive house, without the scare factor, virgin passive house builders tend to whack the rates up: they think of how much it will cost to build, then double it!

"So what we did was, the client employed the (mainly local) contractors for the separate trades — including some being paid on an hourly rate — and set up an account at the builders' merchants. That way everyone was paid fairly, but no-one was making a massive profit. It came in on budget and on time."

With no single contractor carrying the can for passive house quality, instead, they built in quality assurance separately. "We arranged it so that the timber framers would be paid only when the shell was airtight to below 0.6. For the insulation installation, we employed a local independent consultant to check the insulation fill thermographically as it was going in, to ensure there were no gaps. For the ventilation system, a local plumber did the installation, then Green Building Store came and commissioned it."

Building on this positive experience, especially the speed of erection on site, EcoArc have started to work with a local timber frame firm, Eden Frame, to develop their own passive house timber frame system. "We do more of the construction offsite — the panels are pre-insulated, that makes it even quicker to erect. The panels then slot together with thermal bridge free dog-leg joints at the corners: there are not many joints though — the panels are really large," Andrew says.

"This means a frame can go up in one day, and the roof goes on the following morning."

It isn't just EcoArc, but the clients too, who hope more homes like this will be constructed in the area. In their design, access and environmental statement to the planning authority (the Lake District National Park) the clients stressed the need to develop housing solutions in the area that protect and sustain the environment – that means homes that are energy efficient, sustainable and cost-effective.

Their own house certainly shows just exactly how this can be done.

SELECTED PROJECT DETAILS
Architect: EcoArc (Andrew Yeats)
Timber frame: MBC Timber Frame
Contractors: Sam Nelson & Jim Crawford
Civil & structural engineering: Peter de Lacy Staunton
Passive house consultant: Passivate
Cellulose insulation: Warmcel
Glass wool insulation: Knauf
Quantity surveyors: Bushell Raven
Mechanical contractor: Nick Dent
Electrical contractor: Phillip Townson
Airtightness testing: Paul Jennings
Additional wall insulation: Kingspan
Airtightness products: Siga/Ampac
Windows & doors: Ecohaus Internorm
MVHR: Green Building Store
Solar thermal collectors: Consolar
Solar PV: Lakes Renewables
Thermal store: Akvaterm
Cladding: Marley Eternit
Building boards: Fermacell
Concrete block: Aggregate Industries
Rainwater harvesting system: Rainwater Harvesting Ltd

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(right) the Viking House passive slab insulated foundation system includes 300mm of EPS insulation; (above) the house is clad with silicone render on the ground floor and Eternit Cedral weather board on the first floor; (p33, top to bottom) the roof features an Ampatop Protecta breather membrane outside the rafters to the timber structure; metal web joists create neat runs for MVHR ducting; pre-fit strips of airtight membrane ensure stud walls don't pose an infiltration risk; the 500 litre Akvaterm thermal store

PROJECT OVERVIEW:

Building type: Detached two-storey timber frame house with total floor area of 151.8 square metres (including garage and conservatory)

Location: Staveley, Kendal, Cumbria, UK (Lake District National Park)

Completion date: June 2014

Budget: £208K

Passive house certification: pending

Space heating demand (PHPP): 15 kWh/m^2/yr

Heat load (PHPP): 10 W/m^2

Primary energy demand (PHPP): 112 kWh/m^2/yr

Airtightness (at 50 Pascals): 0.58 ACH or 0.52m^3/m^2/hr

Energy performance certificate (EPC): A (numerical score 104)

Thermal bridging: Bespoke cold bridge free junction detail design by Eco Arc. Extensive Psi-Therm 2D modelling by Passivate of all key junctions. Resultant calculated cold bridge PSI- value 0.02283 W/mK, fRSi-value 0.91.

Ground floor: 20mm reclaimed maple flooring, on 50mm battens with glass wool insulation between, on 100mm thick reinforced concrete floor slab, on 300 mm EPS insulation as part of Viking Passive Slab insulated foundation system (PHI certified). U-value: 0.105 W/m^{2}K

Ground floor walls: 10mm thin coat silicone render, on 100mm recycled aggregate concrete block, on 50mm ventilated cavity, on wind-tight membrane, on 12mm sheathing board, on MBC 300mm preservative treated Larsen twin wall with full-fill Warmcel 500 cellulose insulation, on 12mm OSB to MBC/Viking House specifications with taped joints, on Siga Majpell airtightness membrane and vapour control layer, on 50 x 50mm battens to form service void insulated with glass wool insulation, on 12.5mm Fermacell board. U-value: 0.11 W/m^{2}K

First floor walls: Eternit Cedral weather boarding, on 50 x 50 mm vertical battens to form ventilated cavity, on wind-tight membrane, on 12mm sheathing board, on MBC 300mm preservative treated Larsen twin wall with Warmcel 500 full fill cellulose insulation, on Siga Majpell airtightness membrane and vapour control layer, on 12mm OSB, on 50 x 50mm battens to form service void insulated with glass wool insulation, on 12.5 Fermacell board. U-value: 0.11 W/m^{2}K

Roof: Recycled slates externally followed underneath by ventilated cavity, Ampack Ampatop protect roofing membrane, on Bob tail fink truss rafters at 600 c/c with 620mm full fill Warmcel insulation, followed underneath by vapour control layer / air tightness barrier, 25 x 50mm battens to form a services void, 12.5mm on 12.5 Fermacell board. U-value: 0.065 W/m^{2}K

Windows: Internorm KF410 triple-glazed aluminium clad windows and doors with ISO glazing spacers. Overall U-value: 0.72 W/m^{2}K

Heating: 1kW electric heater element in MVHR duct. Consolar solar thermal system, consisting of three panels covering 7.8 square metres, delivering heat to 500 litre Akvaterm solar thermal store.

Ventilation: Passive House Institute certified Paul Focus 200 MVHR unit with short self-insulated EPP ducts to outside. PHI certified heat recovery rate 91%.

Electricity: 4kWp solar PV system using 16 Hyundai 250W modules, linked to Immersun controller unit to transfer excess electric to Akvaterm solar thermal store.

Water: F-line Flat Tank 3000 litre underground domestic rainwater harvesting system kit with mains backup, overflow to 1m^3 soakaways located in the garden.

Green materials: Recycled slate roofing, recycled maple timber flooring, cellulose insulation, FSC-certified timber, recycled stone for external patio & paths, recycled granite for external table.

RED BRICK SURREY HOME

becomes an unintentional passive house

The team behind this Surrey home intended to use it as a test-bed for passive house design and construction, without necessarily expecting to achieve certification. But as the house neared completion, they realised that they were within touching distance of the coveted low energy standard.

Words: Will South, certified passive house designer, Cocreate Consulting

A local talk on passive buildings was all the inspiration our client, developer Christian Staunskjaer, needed to consider applying the standard to his own projects. He had received some great initial advice, and sought mine as a passive house designer to find out what would be involved.

Initially we went through Christian's current project portfolio and looked for opportunities to bring elements of the standard in. The intention was always for the first project to be for experience — using the principles, products and techniques to hone what would be required to deliver passive house on future sites. Whipley Lodge was the obvious choice for a first go. It had received planning consent for a new build detached house on a very open brownfield site.

Looking back, Christian says: "Once I started looking into passive house it made a lot of sense. We try and focus on local materials and the quality of finish — passive house makes sure we go to the same lengths for construction quality and energy use." There was also a lot of frustration with elements of the Code for Sustainable Homes targets, and the desire to show prospective buyers that these properties were different from others available. I was very keen to help and pleased to see a private developer recognising value in the passive house standard.

Our initial look through the planning scheme offered great examples of how to make things difficult. Complicated shape? Check — cruciform with a partial room in the roof. Huge amounts of glass? Yes — facing west beneath a line of trees. Dormer windows? Lots! But Christian and the designer Jags Architechs were more than aware of the difficulties, and were refreshingly open to making changes. I spent a good afternoon going through the PHPP model with them trying things out.

We found extra savings in simplifying the window designs, moving windows to the south facade facing the garden, and developing the dormer window design so they were incorporated into the roof. There were other changes required to satisfy the planning conditions and our changes were accepted. "We initially didn't think it would be possible because of the complicated footprint, but the changes Will recommended were fairly simple to incorporate with the layout," says Jags' Gary Evans.

After doing what we could in the PHPP modelling we were still short of the specific heat demand target, but didn't want to push the fabric beyond what was economical. There were also a number of unknowns as the real work began of researching and recommending products and materials, finalising details and appointing the all important contractor team.

We were lucky that Christian manages his own projects and was well versed in finding the right solutions. Our role became making suggestions from experience on other projects, and making performance checks on the key suppliers. In hindsight among the best of these were the timber frame suppliers Eco-homes, who brought a wealth of airtightness experience from passive house and low energy building in Ireland. This was evident at first fix where the air barrier was given top priority. This meant only one extra air-test was needed during construction to give us confidence we could meet the passive house air infiltration target.

Passive house M&E engineer Alan Clarke lent ▶

his experience for the services design, and despite the building not being connected to mains gas, he kept things really simple with a liquified petroleum gas (LPG) tank supplying a standard gas boiler. This would probably surprise people on such a low energy building, but gas was attractive for a few reasons — low maintenance, easy usability, and good efficiency when delivering the big temperature differences needed to supply both hot water and minimal space heating. The amount of hot water needed at Whipley Lodge is likely to be much larger than the space heating requirement, on paper at least.

As this was my first complete passive house project, I made sure to get on site as often as I could. This culminated in me installing the MVHR system myself, putting my design input to the test and learning a lot about what to look for and specify next time. Spending a few days on site gave me good insight into the understanding, frustrations, and pride that the other trades took from working on a passive house. Tying it all together was the site manager Byron Killick who was also new to passive house. He says: “A lot of it is just doing a good job, which we try to do anyway. Now someone checks it and says well done, and there's a test at the end to see how good my taping was!”

I was on site during the preliminary air-test and was pleased to see the plumber Ben Skeet downing tools and checking his soil vent pipes and other penetrations. He also introduced me to the idea of putting rubber gloves over the ends of the ducts as a quick way to stop construction dust getting in. This made for a bit of amusement when we ran the de-pressure air-test.

As the project progressed our original concerns became hazier. “As soon as you think you might get there, it's quite hard to give it up!” said Christian at one of our meetings on site. We started looking for other easy wins as the building went up. The most effective of these was more or less an accident after some clear thinking from the site team — increasing the depth of blown cellulose insulation in the cold roof space. “We had a spare pack on site and it made more sense to put it in the roof than take it home,” says Alan Spillane of Ecohomes.

Following this we pushed harder on the design side, finding extra savings by slightly improving the window installation, and I added an extra layer of insulation to the MVHR ducts. This was slightly annoying as I'd got the first layer spot on and couldn't get cutting templates for the larger duct diameter, plus 50mm of the Armaflex insulation was really a very tight squeeze between the ducts on top of the unit, meaning the finish wasn't quite as good as I hoped.

But all this brought us just within touching distance of the 15kWh/m^2/yr a target. Meeting the passive house standard came down to getting a good blower door test result, and everyone could feel the pressure (50 Pascals worth of it to be precise). After some tense moments the result came in at 0.43 air changes per hour to seal our achievement — a certified passive house, and a personal best result for the tester as well.

SELECTED PROJECT DETAILS
Client: Low Energy Developments
Architectural consultant: Jags Architechs
Passive house design: Cocreate Consulting
Timber frame: Ecohomes
M&E design: Alan Clarke
Mechanical contractor: AB Plumbing & Heating
Insulated foundation system: Isoquick
Windows & doors: Norrsken
LPG boiler: Worcester Bosch
Ventilation ductwork: Lindab
Roof window: Passivhaus Store
Passive house certification: Warm

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“We try and focus on local materials and the quality of finish — passive house makes sure we go to the same lengths for construction quality and energy use.”

(above and below) the 220 square metre detached house in Surrey is clad with red brick, giving it a traditional appearance; (opposite, top) installation of the Norrsken Viking triple-glazed timber-framed windows; (middle) the open truss timber roof system (bottom, left to right) the house’s timber-frame walls; rubber gloves over the end of MVHR ducting stopped dust getting in during construction; the Paul Novus passive house certified heat recovery ventilation system delivers fresh air throughout the house

PROJECT OVERVIEW:

Building type: 220 square metre detached two-storey timber frame house

Location: East Whipley Lane, Cranleigh, Surrey, UK

Completion date: Aug 2014

Budget: £475,000

Passive house certification: Certified

Space heating demand (PHPP): 14.7 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 105 kWh/m²/yr

Airtightness (at 50 Pascals): 0.43m³/m²/hr

Energy performance certificate (EPC): B 83

Thermal bridging: Thermal bridges completely designed out using internal structure on raft foundation, and I-joist timber structure to reduce repeat bridging. Window frame junctions wrapped externally with insulation.

Ground floor: Isoquick Passive House Institute raft foundation system insulated with 300mm EPS insulation. U-value: 0.118 W/m²K

Walls: Ecohomes factory-built I-joist timber frame with external flemish bond cavity face brickwork. Timber frame construction of 22mm wood fibre board externally followed inside by 345mm Isocell cellulose-filled between I-joist timber studs, 15mm taped and sealed Smartply OSB-3, 50mm service cavity insulated with Rockwool insulation, and 15mm Plasterboard internally. U-value: 0.114 W/m²K

Roof: Clay pan tiles on battens, followed underneath by Tyvek breathable roofing underlay, open timber truss roof with 500mm of loose fill Isocell cellulose insulation, taped and sealed Isocell air-tight membrane with uninsulated suspended ceiling beneath. U-value: 0.085 W/m²K

Windows: Norrsken Viking triple-glazed insulated timber frame windows, low-e argon filled triple glazing and an overall installed U-value of 1.05 W/m²K

Roof window: Fakro triple-glazed U6 rooflights with argon fill and fitted with EHV-AT Thermo flashing kit. Overall U-value: 0.81 W/m²K

Heating system: 95% efficient Worcester Bosch condensing LPG gas boiler supplying underfloor heating and 300 litre buffer tank, plus two Worcester Bosch flat plate solar collectors supplying a separate 240 litre domestic hot water tank. LPG gas tank sunken into garden at entrance.

Ventilation: Paul Novus 300 heat recovery ventilation system — Passive House Institute certified to have heat recovery rate of 93%

Green materials: Reclaimed bricks, cast iron gutters and down pipes. Timber frame with cellulose insulation.

New London classroom brings passive comfort to school prefabs

PassivClass, a new passive-certified modular classroom in London, aims to end the days of cold and draughty school prefabs – including a structure made from reclaimed materials.

Words: Lenny Antonelli

In recent years the UK has seen a huge increase in demand for pupil places. Nowhere has this requirement to provide more classroom space been more keenly felt than in London.

Paul Callaghan, a chartered builder and architectural designer, works in the education sector and helps local authorities expand their schools to meet rising demand. Having extensively used modular buildings in the past to meet last minute requirements for places, he saw an opportunity to improve on the method.

"Over the last couple of years I have been called last minute to provide additional spaces for bulge classes," he says, "these urgent requirements reach me in about late April and May, and have to be completed by the end of August.

"Allowing for planning, design and procurement, by the time the contract has been instructed only about eight weeks are left to construct the building. This has pushed me down the modular off-site building route."

Callaghan estimates that over the last two years he has procured 20 modular classroom buildings, equivalent to almost two new schools. "The volumetric buildings I have typically specified provide light education spaces with air conditioning and are generally very well received by the schools in which they are placed. I did however have concerns over indoor air quality and long term energy performance."

When another request came in for a 30 child classroom building from Smallwood Primary School in Tooting, Callaghan decided to procure the building based on a pre-fabricated passive house design. The original instruction was received on 2 May 2014, with the building to be completed by 2 September.

Callaghan had yet to cut his teeth on a passive house building, but he modelled the proposed classroom in PHPP and determined that it could achieve the passive house standard. "I produced a design and build tender which incorporated my PHPP spreadsheet, a quote for passive house windows and details of the main building junctions. My desired design featured an off-site manufactured timber studwork with an insulated ground bearing slab."

The lowest tender he received used a standard volumetric building system with a suspended timber floor. The winning contractor, Cotaplan, had not built a passive building before and asked Callaghan to come on board as their passive house designer.

While the contractor was keen to meet the passive house standard, they did not want to completely change the way they build. Mark Fielding of Cotaplan says: "In building PassivClass we did not want to re-invent the wheel on how our buildings are constructed. Part of the efficiencies in our industry come from the familiarity of the erectors with how the system goes together. We wanted Paul to enhance our existing systems to meet passive house."

The structure of the flat pack system used by

Cotaplan uses repeating steel columns, steel floor beams and a glulam roof ring beam. The use of steel in the construction created the potential for thermal bridging which had to be carefully designed out.

All of the revised details were modelled in Therm and then checked by the passive house certifier, Warm. The form factor of the small building meant that very low U-values were required to meet the standard.

Major structural elements of the building have been reclaimed from ex-hire modular buildings, meaning that the floor cassettes, roof cassettes, wall steels and roof beams are all re-used. This use of cradle-to-cradle elements makes PassivClass 60% re-used by weight, reducing its impact on the environment, and its cost.

Cotaplan's Mark Fielding says: "In building PassivClass we wanted our erectors and usual sub-contractors to gain knowledge of how these new passive house buildings go together. For this first building Paul visited the site daily to check the work and teach our erectors how to build an airtight building.

"Going forward however we want them to be able to do quality control on site themselves and have a good understanding of what it means to build passive." The final air test of the building gave an impressive figure of 0.3 air changes an hour.

The Green Building Store provided timber triple-glazed windows, airtightness tapes and the Paul Novus heat recovery ventilation system.

To address the issue of indoor air quality and in particular carbon dioxide levels inside, the MVHR unit is controlled by a carbon dioxide monitor. This 'throttles' the MVHR unit depending upon the level of CO_2 in PassivClass.

The only source of energy for the building is electrical — there is an in-duct heater in the ventilation system, and an electric radiator for the coldest days of the year. A meter was installed on the electricity supply to the building on the 2 September 2014 and was checked on the 20 January 2015, with a reading of 3208 kWh.

Making a rough calculation and averaging this 20 week measurement over 52 weeks yields a total energy usage of 8341 kWh or 101 kWh/m²/yr, which compares favourably against the PHPP primary energy calculation of 103 kWh/m²yr.

Extrapolating this to reflect the classroom's total energy use over the course of a real school year, including holidays, at the 9.5p per kWh the school pays gives a total annual energy bill of £674.00 — about one third that of a typical school prefab classroom, according to Callaghan.

SELECTED PROJECT DETAILS
Client: Wandsworth Borough Council
Architect & energy consultant: Calsurv Ltd
Main contractor: Cotaplan Ltd
M&E design, airtightness products, windows, doors & MVHR: Green Building Store
Passive house certifier: Warm
Plasterboard: Siniat
Vinyl flooring: Altro
PIR insulation boards:
Ballytherm, Quinntherm, Ecotherm

Want to know more?

Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.

This content is exclusively available to our digital subscribers.

PROJECT OVERVIEW:

Building type: 83 square metres single classroom building complete with cloak room, adult DDA WC, student WC, class space.

Location: Tooting, London

Completion Date: September 2014

Passive house certification: Certified

Space heating demand (PHPP): 15 kWh/m²/yr

Heat load (PHPP): 9 w/m²

Primary energy demand (PHPP): 103 kWh/m²/yr

Airtightness (at 50a): 0.3 air changes per hour

Thermal bridging: The initial structure of the building featured extensive thermal bridging which was designed out. The main bridging elements were:

Wall steel columns: 95mm square section steel columns are placed at 2.5m spacings in the external wall. They were externally and internally faced with PIR board, on the inside face of the wall PIR columns were adhered to the OSB wall layer which overlapped the columns by 50mm and provided an overall negative thermal bridging.

Floor wall abutment: 70mm steel Z sections hold the floor joists in place and support the base of the timber framed walls. The sections were filled with PU foam externally with PIR board between and above the joists. The bridging element was effectively placed outside of the insulated element creating a slight positive bridge at the wall and floor abutment.

Roof wall abutment: The large glulam beam running around the roof perimeter posed a substantial bridge; by again 'in boarding' the insulation the overall construction yielded a slight positive bridge value.

Foundations: Concrete pads supporting the corners and centres of the floor cassettes.

Suspended floor: Z section beams with 95mm polystyrene-insulated timber joists supporting a further 125mm depth of PIR overlaid with OSB. Altro vinyl flooring to finish. U-value: 0.111 W/m²K

Walls: Cedar cladding on batts, on Tyvek breather membrane, 140mm PIR-insulated studwork, on a further 125mm PIR insulating board, on OSB, on 1200 gauge polythene air barrier taped with Pro Clima Tescon Vana tapes, on 18mm Siniat plasterboard. U-value: 0.099 W/m²K.

Roof: Slate roof on batts, on Tyvek breather membrane, on glulam beams with 145mm PIR-insulated intermediate joists, on 300mm Rockwool insulation, on 1200 gauge polythene air barrier taped with Pro Clima Tescon Vana tapes, on suspended 18mm Siniat plasterboard ceiling. U-value: 0.069 W/m²K.

Windows: Green Building Store Ecocontract triple-glazed windows with Planitherm glazing and insulated timber frames. Overall U-value: 0.8 W/m²K.

Heating & ventilation: Paul Novus 450 Passive House Institute certified heat recovery ventilation unit. In-duct heater in ventilation supply air, plus electric LST programmable back-up radiator.

Green materials: Completely re-used structure, FSC certified timbers, BRE Green Guide A+ rated materials including Siniat GTec MF ceiling system & GTec Ladura plasterboard, Altro vinyl flooring and Dulux paint.

(above) the PassivClass features triple-glazed Ecocontract windows from the Green Building store, with insulated timber frames; (below, left to right) 145mm PIR boards between the roof joists; 140mm PIR boards between the timber-frame with additional 125mm boards mid-installation inside; OSB encases the wall insulation and a suspended ceiling system house with 300mm depth to take a Rockwool layer; (opposite page) belying the typical of look of school prefabs, PassivClass is clad externally with cedar boards

Norfolk social housing

hits passive for standard costs

Twelve units in Great Yarmouth deliver low energy bills and comfort for new tenants using patented timber frame system.

Words: Lenny Antonelli

A new social housing development in Norfolk has achieved passive house certification — and without costing a premium. The Bradwell development in Great Yarmouth is one of the most recent passive house projects from Norwich-based Beattie Passive, a design-and-build company with its own patented timber frame system.

Before starting the company, managing director Ron Beattie had worked as a carpenter, electrician and plumber, before going into property development. He says that he always built green, energy efficient housing, but he had a watershed moment on a building site six years ago.

"I was standing on scaffolding looking down," he says. "I looked down the cavity and there was no insulation. One bricklayer had not put the insulation in."

Ron says that, because of an emphasis on extras like solar panels, it was costing more than it should to build energy efficient housing. Though his developments were well insulated, seeing the uninsulated cavity made him realise the importance of focusing on a properly insulated, airtight and fully tested building fabric over 'green bling'.

Ron read about passive house, and his interest was piqued. He went on a study trip to Belgium with leading passive house certifier Peter Warm, and also met Passive House Institute founder Wolfgang Feist. He set out to develop a build system that not just delivered passive house energy efficiency, but also improved fire safety, acoustics, buildability, cost, flood protection — and could be built anywhere.

He launched Beattie Passive and its timber-frame system, which is now certified by the Passive House Institute and patented in 52 countries. The system features a continuously insulated void running through the floor, roof and walls. This void is pumped with Ecobead, and Kingspan Kooltherm phenolic board is fitted externally to improve the U-value further. The Eco-Slab ground floor system, which forms the ventilated floor void, is also insulated with Ecobead. The spec also includes a party-wall build up that delivers a U-value of 0.13, plus passive certified Munster Joinery windows.

"It is really simple to do. You follow a methodology and it works every time," Ron says of the system. The company has now built eight certified passive houses, and has another 14 or so pending certification. This is in addition to more than 100 uncertified projects, which use the same system but don't go through the certification process. "Every Beattie passive house is tested on structural completion for structural compliance, thermal conductivity, sound and air testing, and then certified that it is built as designed," Ron says.

At Bradwell in Great Yarmouth, Beattie Passive was brought in to develop 12 social housing units. These were the first council houses built by Great Yarmouth Council for over 25 years, and the latest in a recent string of passive projects by UK-based councils and social housing landlords, who increasingly see the ultra low energy standard as a way to cut energy bills and ensure warmth and comfort for their tenants.

Four of the units here (in two semi-detached blocks)

are certified passive. The other eight are built to the same spec, but being bungalows with a larger surface area and with less solar gain (due to overshadowing on the tight site), they are just outside passive house parameters.

Using local labour was one of Beattie Passive's main goals on the project. "Ten of the units were manufactured by the kids in Great Yarmouth College," Ron says. Carpentry students manufactured the timber frames for the bungalows in the college. This model, of encouraging young people to train and develop their skills while building a passive house – for a wage – is one Beattie Passive has used on other projects too.

"Part of the ethos of Beattie Passive is about training young people to be the passive engineers of the future," says Ron. Because the labour is semiskilled, it helps to keep build costs down too. There was also a wider emphasis on using local suppliers and labour on the job and, according to Beattie Passive estimates, for every £1 spent on the Bradwell project, £2.84 was circulated back into the local economy.

Beattie Passive has published a breakdown of the costs for two of the certified passive houses at Bradwell on its website: www.beattiepassiveprojects.com. The total build cost was £65,785 per unit, which comes to £842 per square metre or £78 per square foot, including all labour, internal finishes and external render, but not external site works, preliminaries, fees, overheads, profit and services. "To make passive work it's got to be at the same price as standard building costs," says Ron, "Beattie Passive is."

The Bradwell houses are primarily heated with ▸

"To make passive work it's got to be at the same price as standard building costs"

(above and below) the patented Beattie Passive timber frame system being erected on site. The system's 220m deep timber studs are insulated with Ecobead, with Kingspan Kooltherm phenolic board also installed externally; (p43) using local labour was one of Beattie Passive's goals on the project, and ten of the units at Bradwell were manufactured by carpentry students at Great Yarmouth College

condensing gas boilers; there are also Genvex heat recovery ventilation systems. Resident Paula Bastin moved into one of the semi-detached homes last October, having previously lived in a ground floor flat.

Paula is partially sighted, and says the house has massively improved her quality of life. "My personal experience is that it's just given me and my daughter a whole new lease of life, because of my eyesight," she says. This is less related to the house's energy performance than the fact she now has her own garden, where it's easier to watch her daughter, and because the area is safe and quiet.

But she adds that in her first three months in the house, over the winter, her total bill for gas and electricity was about £80, whereas she had previously been paying about £100 a month for the two. She says that cooking alone is often enough to heat the house up, so she won't need to turn the heat on.

She's also impressed with the air quality inside. As expected, the house is very comfortable, "All the crap air is going out automatically without having to open too many windows," she says.

"We're just very comfortable here," she says, "it feels like we've been here forever."

SELECTED PROJECT DETAILS
Client: Great Yarmouth Borough Council
Architecture: NPS Property Consultants Ltd
Timber frame: Beattie Passive / Great Yarmouth College
Contractor & project management: Beattie Passive
Building physics: Encraft Ltd
Structural engineer: Canham Consulting
M&E engineer: Total Home Environment
Windows & doors: Munster Joinery
Electrical contractor: Norman Electrical
Airtightness testing: UK Air Testing
MVHR: Genvex, via Total Home Environment
EPS insulation: EcoBead, via Help-Link
Phenolic insulation: Kingspan, via SIG Insulation
Airtightness products: Pro Clima, via PYC Systems
Damp proof membrane: Travis Perkins
Cladding: Euroform
Gas boiler: Ideal Heating

Want to know more?

Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.

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PROJECT OVERVIEW:

Building type: two x two-bed timber frame certified passive dwellings, each 78 square metres

Location: Bradwell, Great Yarmouth, Norfolk

Completion date: October 2014

Budget: £65,785 per unit

Passive House Institute certification: Certified

Space heating demand (PHPP): 14 & 15 kWh/m²/yr

Heat load (PHPP): 9 W/m² & 9 W/m²

Primary energy demand (PHPP): 110 kWh/m²/yr & 109 kWh/m²/yr

Environmental assessment method: Code for Sustainable Homes level four

Airtightness (at 50 Pascals): 0.5m ACH & 0.4 ACH

Energy performance certificate (EPC): B 85

Thermal bridging: Beattie Passive patented complete thermal insulation system. Y-value (based on ACDs and numerical simulations): 0.01 W/mK

Ground floor: Precast concrete foundation beams followed above by Eco-Slab laid to form vented void and insulated with Ecobead, 150mm concrete floor beam, exterior OSB boarding laid over floor. U-value: 0.8 W/m²K

External Walls: Thermal envelope features 60mm Kingspan Kooltherm K5 externally, followed inside by 15mm Versapanel board, 220mm timber studs insulated with Ecobead, 15mm Versapanel, 25mm service cavity and 13mm plasterboard internally. U-value: 0.11 W/m²K

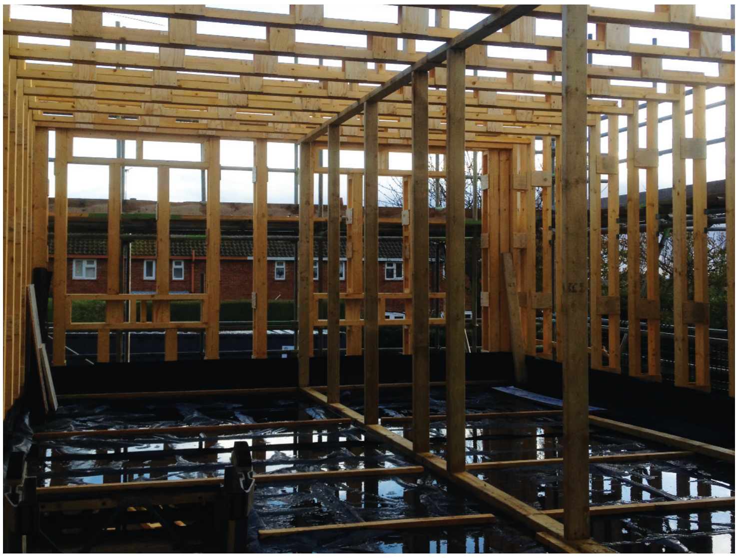
Party walls: Feature 50mm Rockwool flex sound insulation and cavity 100 mm void pumped with Ecobead. Sound tested to 57DB. U-value: 0.13 W/m²K

Roof: Thermal envelope features breather membrane externally followed beneath by 80mm Kingspan Kooltherm K5, 220mm timber studs insulated with Ecobead, 12mm Versapanel, 100mm service cavity, 13mm plasterboard. U-value: 0.8 W/m²K

Windows & doors: Munster Joinery Future Proof Passiv uPVC triple-glazed. Argon fill, low-e coatings, chambers insulated with PU foam. Passive House Institute Certified. U-value: 0.8W/m²K

Heating: Logic+ Combi condensing gas boiler, 90% efficiency, supplying hot water, radiators to sitting room and towel rail to bathroom

MVHR: Genvex GES EnergyOpt100 MVHR unit. Passive House Institute certified heat recovery efficiency of 81%.



Passive research centre

acts as living showcase for green tech

A new research centre in Northern Ireland could stake a claim as being one of the greenest buildings on these islands. Not only is it passive, it boasts a whole suite of ecological features, and aims to be at the cutting edge in the research and development of new sustainable and renewable technologies.

Words: John Hearne

The Crest Pavilion which now forms part of the South West College campus in Enniskillen wears its sustainable credentials on its sleeve. It's the first building in the UK to meet three separate sustainable standards: passive house certification is pending, as is Breeam Excellent accreditation, while the building has also been designed to be net carbon neutral in terms of "regulated" energy use – including energy used for heating, ventilation, lighting, etc., but excluding "unregulated" energy use by occupants for cooking and operating electric appliances.

The ambition that drove the project towards these standards was written into the building's DNA. Crest, the Centre for Renewable Energy and Sustainable Technologies, is a research

facility designed to foster innovation in these fields.

Funded by the EU together with the UK and Irish governments, the facility is available to both businesses and individuals within Northern Ireland, the border counties of Ireland, and western Scotland, who have ideas for relevant products or process developments but don't have the physical or technical capacity to develop or commercialise them. The centre includes lab space, testing equipment and demonstration technologies, while technical staff are also available to help bring ideas to the next stage of development.

The centre also functions as a living demonstration of itself. It's a showcase of the sustainable building methodologies and renewable technologies which it embodies. In the words of architect Paul McAlister: "The building itself is the story of sustainability."

"The initial brief was that the building had to be passive house certified and it also had to be Breeam Excellent," he explains. "We thought well, if it's Breeam Excellent, and passive house, why not make it carbon neutral?"

McAlister was Northern Ireland's first passive house designer. Two years ago, after completing a new passive build in Co Down, he published detailed costings for the project, which demonstrated just how cost-effective passive house had become in Northern Ireland. The meticulous attention to detail that delivered that project was also brought to bear on this project, where the tender process put cost ahead of all other considerations.

The project team was presented with a brownfield site, overlooked by a large wind turbine. There was, however, sufficient space and latitude to orient the building towards the south to optimise passive solar gains, and still create links between existing college buildings.

"Form always follows function," says McAlister, explaining that the large lecture room the pavilion required was sited at the southern elevation, which is extensively glazed and dominated by a large overhang and an extensive louvered section to prevent summer overheating. "We also have high level glazing in the exhibition spaces, which has the advantage of bringing in passive solar gain when we need it, in the spring, autumn and winter. Again, the form of the building responds to the need for both passive solar gain and light. We're ticking both boxes."

Both bathrooms and plant room are sited on the northern elevation, where glazing is minimised. The plant room was deliberately oversized, specifically to facilitate easier access and give visitors the space to view the renewable technologies incorporated in the building.

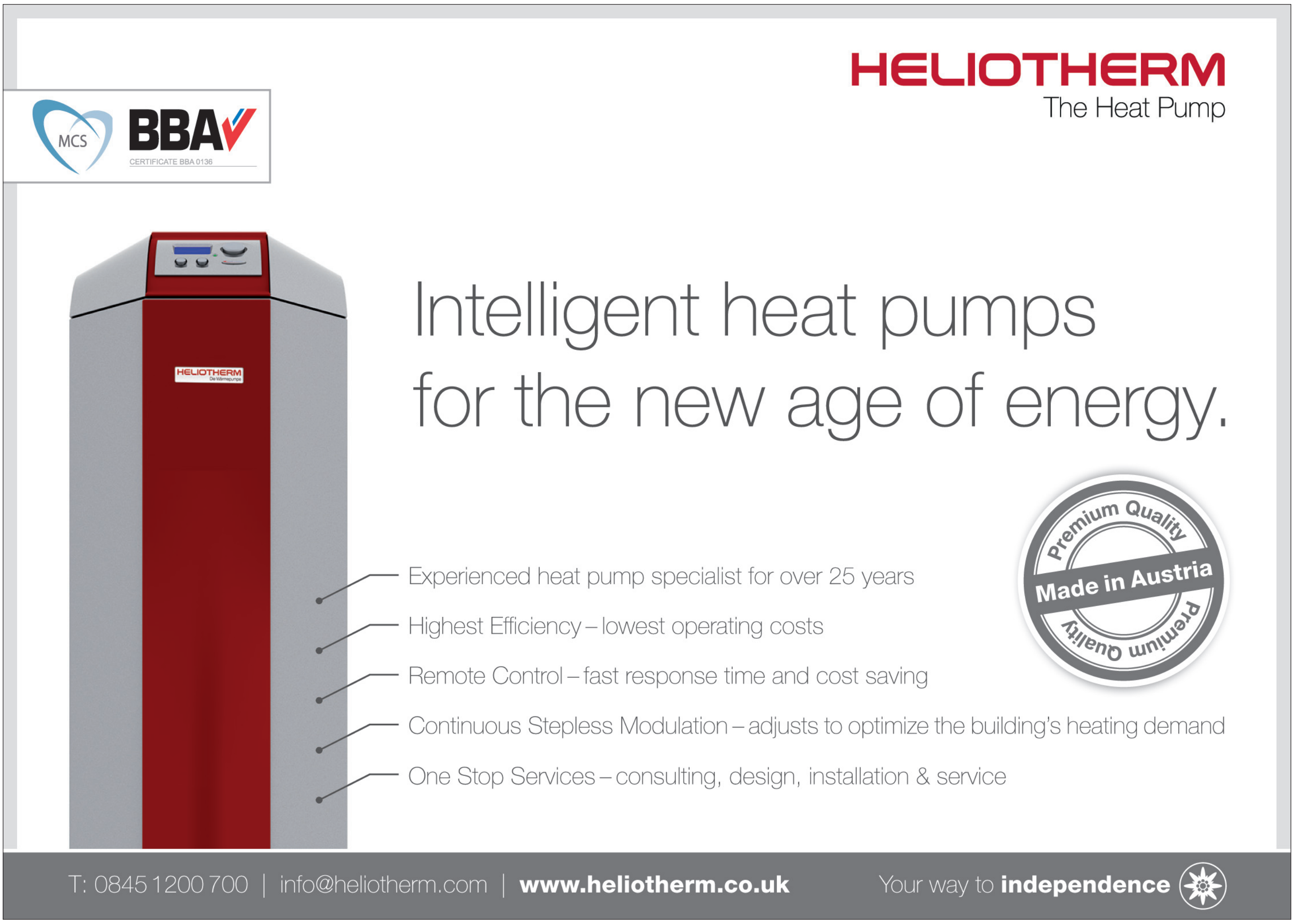
"You can probably fit about half a dozen people in there comfortably," says Crest manager, Tim Stokes. "You can go right around the heat recovery system, you've got the air source heat pump, the rainwater harvesting controls, the building management system (BMS) in there. And outside on the wall, we've got diagrams showing how the systems work."

Stokes explains that a screen is to be installed in the reception area which will show the building's energy usage and production stats in real time. "Once you've sealed up the walls, it makes it difficult for people to see exactly what's gone on in there," he says, "whereas we've made an effort to help people to interpret the building and show them how it works."

Building to the passive house standard meant a super-insulated structure. Meanwhile Breeam, and its emphasis on using low embodied energy materials, led the design team away from steel and towards timber. Structural insulated panels — made up of polyurethane insulation sandwiched between OSB boards — were chosen for walls and roof. The factory-built panels made for fast, precise onsite assembly. Preformed openings for windows and doors cut down on waste and sped up construction. Each element is constructed on the ground and then lifted into place by crane.

The glulam timber framing system was chosen for several reasons, says architect Paul McAlister: low embodied energy, the fact that the timber came from sustainable sources, and efficient assembly. But it wasn't simply about function. "The timber structure of the pavilion is expressed in the internal spaces as part of the aesthetic of the scheme, and creates an elegant interior space."

A thermal model of the building was created early in the project, allowing the design to be tested and modified to make sure it would meet the desired passive house target space heating demand of 15kWh/m^2 per annum. McAlister explains that while simultaneously chasing three ▶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“The building itself is the story of sustainability.”

separate sustainability criteria added to the complexity of the build, there were obvious synergies too.

“The carbon neutral target helped a lot with the Breeam points,” he says. “We got almost all of the available points for energy. We had an extremely efficient building, and one that was generating all of its own electricity for lighting and heating, so from that point of view, it made our job of getting Breeam Excellent a lot easier.”

“Passive house and carbon neutral are a very good fit. You have a very efficient building, so you need fewer renewables to get it carbon neutral.”

Airtightness, is of course, one of the pillars of passive building. Achieving the passive target of 0.6 air changes per hour required a great deal of extended effort on the part of the contractor, PJ Treacy & Sons. Sean McCarron was Treacy’s man onsite. “Maybe the best thing to say is that it was a learning curve for all concerned...but we did achieve the target in the end.” McCarron explains that airtightness was delivered primarily using a combination of airtightness membrane and tapes.

The building’s timber walls are constructed on thermal block sub walls, with perimeter insulation around the inside of the external walls to help eliminate cold bridging. The connections between the structural insulated panels are formed using expanding glue and screw fixings to ensure a thermally continuous joint. In addition, a 20mm shadow gap was created between the vertical glulam columns in the main demonstration area. This allows visitors to see the timber structure as a structural element separate to the walls.

Cold bridging is always a major issue at the junctions between existing structures and the buildings. No such problems arose in Enniskillen however. “The link,” McAlister explains, “is an external walkway, which is a thermally broken element of the build, which means no cold bridging issues arise. The pavilion is entirely standalone. In all, the design team created 56 A1 drawings which detailed away cold bridges from the myriad of internal junctions.

Sean MacDiarmada of Cuilinn Engineering was the M&E engineer on the build. He explains that because of occupancy profiles, building control regulations require more exacting ventilation standards on a commercial building than would be required with a typical dwelling house. Passive house and Breeam targets however meant that achieving those standards couldn’t be done using conventional air conditioning systems, which use a lot of refrigerant — and a lot of energy. Instead, the design team specified a combination of mechanical heat recovery ventilation (MVHR) and a natural ventilation strategy.

An external weather station feeds data to the building management system. “Whenever conditions are favourable,” MacDiarmada explains, “when it’s not freezing cold or bucketing rain or the wind-speeds aren’t huge, the BMS will shut down the MVHR and automatically open up windows to ventilate the building naturally.” This way, you get rapid ventilation and free cooling without the need for fans. In addition, temperature, CO_2 and humidity sensors located around the building trigger vent opening as required.

Between Breeam, passive house, budgetary constraints and building control regulations, getting the ventilation and cooling strategy right was, in MacDiarmada’s words, “exceedingly difficult”. Nor did it help that the building was largely open plan, and that there were no ceiling voids to house ducting systems. MacDiarmada made extensive use of modelling software at design stage to work out the optimal design for the system. “That was a particular challenge,” he says, “working within the restriction of passive house and Breeam, but yet making the building work as a commercial building.”

Breeam also drove the selection of a wide range of low-embodied energy materials in the build: zinc for the roof, cedar cladding on external walls, and the aforementioned timber frame. All lighting is LED, while rainwater collected from the roof is used to flush the toilets, reducing the potable water requirement. Water reduction technologies are also in use throughout the building.

One of the showcase renewable technologies on display is the robotic solar tracker, the first ▶

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of its kind in Europe. Solar PV panels are mounted on a motorised frame which tracks the movements of the sun throughout the day, optimising the efficiency of the system, and bringing the building a long way towards its carbon neutral target.

Crest manager Tim Stokes says that initial reactions to the building — occupied now since January — have been very positive. So far, the pavilion has attracted a range of research and demonstration projects: "We've got things like an air source heat pump rig — a working rig suitable for teaching students and for demonstrating to businesses as well. We've also got a solar hot water installation and a hydropower demonstration system."

"The building has a wonderful feel to it", he goes on, "the exposed timber and the high ceilings give it a warm, open feel. The first comment you always get is: 'This is lovely.'"

SELECTED PROJECT DETAILS
Client: South West College
Architect: Paul McAlister Architects
Contractor: PJ Treacy & Sons Ltd
M&E engineer: Cuilinn Engineering Ltd
Structural engineer: G Dawson Ltd
Breeam assessor: SDS Energy
Quantity surveyor: Giffin Hughes LLP
Mechanical contractor: Thomas Hanna & Co
Electrical contractor: MFE Ltd
Build system supplier: Atek Beams
Structural insulated panels: Sips UK
Windows & doors: Baskil/Munster Joinery
Heat pump: Daikin, via Alternative Heat
MVHR: Zehnder, via Versatile
Thermal Blocks: Quinn Lite
Airtightness membrane: Glidevale
Solar photovoltaic system (design): Castillium
Solar photovoltaic system (supply): Carey Glass Solar
Heating & lighting controls: ATC Systems
Rainwater harvesting: Kingspan
Roofing: Met-Seam Ltd

Want to know more?

Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.

This content is exclusively available to our digital subscribers.

(above) The Crest pavilion has 150 ground-mounted PV panels and a further 60 on the building itself; (p49, bottom) the building was constructed from a factory-built timber frame system insulated with polyurethane, with a Quinn Lite subfloor, while the ground floor features 250mm of Kingspan TF70 insulation under the concrete screed

PROJECT OVERVIEW:

Building type: 532 square metre research and demonstration centre for sustainable and renewable technologies

Location: South West College, Enniskillen, Co Fermanagh

Completion date: December 2014

Budget: £1.4 Million

Passive house certification: Pending

Space heating demand (PHPP): 15 kWh/m²/yr

Heat load (PHPP): 15 W/m²

Primary energy demand (PHPP): 76 kWh/m²/yr

Environmental assessment method: Breeam Excellent

Airtightness (at 50 Pascals): 0.6 air changes per hour

Energy performance certificate (EPC): A

Ground floor: 150mm concrete sub floor followed above by damp proof membrane, then 250mm Kingspan TF70 insulation, then 75mm cement screed U-value: 0.086 W/m²K

Walls: Quinn Lite blocks at sub floor, factory-built timber frame with red cedar cladding externally, followed inside by 50 x 50mm treated battens and counter-batten, breather membrane, 13mm plywood, 200mm polyurethane insulation, 13mm plywood, Protect Barriair airtight membrane and vapour control layer, 50mm service cavity insulated with Rockwool insulation, and 13mm plasterboard internally. U-value: 0.136 W/m²K

Roof: Zinc roofing on Permo Sec roofing membrane, battening and counter-battening, Protect Barriair airtight membrane and vapour control layer, 13mm plywood, 200mm polyurethane insulation, 13mm plywood, 200mm service cavity, 13mm plasterboard. U-value: 0.16 W/m²K

Windows: Baskil triple-glazed aluminium windows, with argon filling and an overall U-value of 0.55 W/m²K

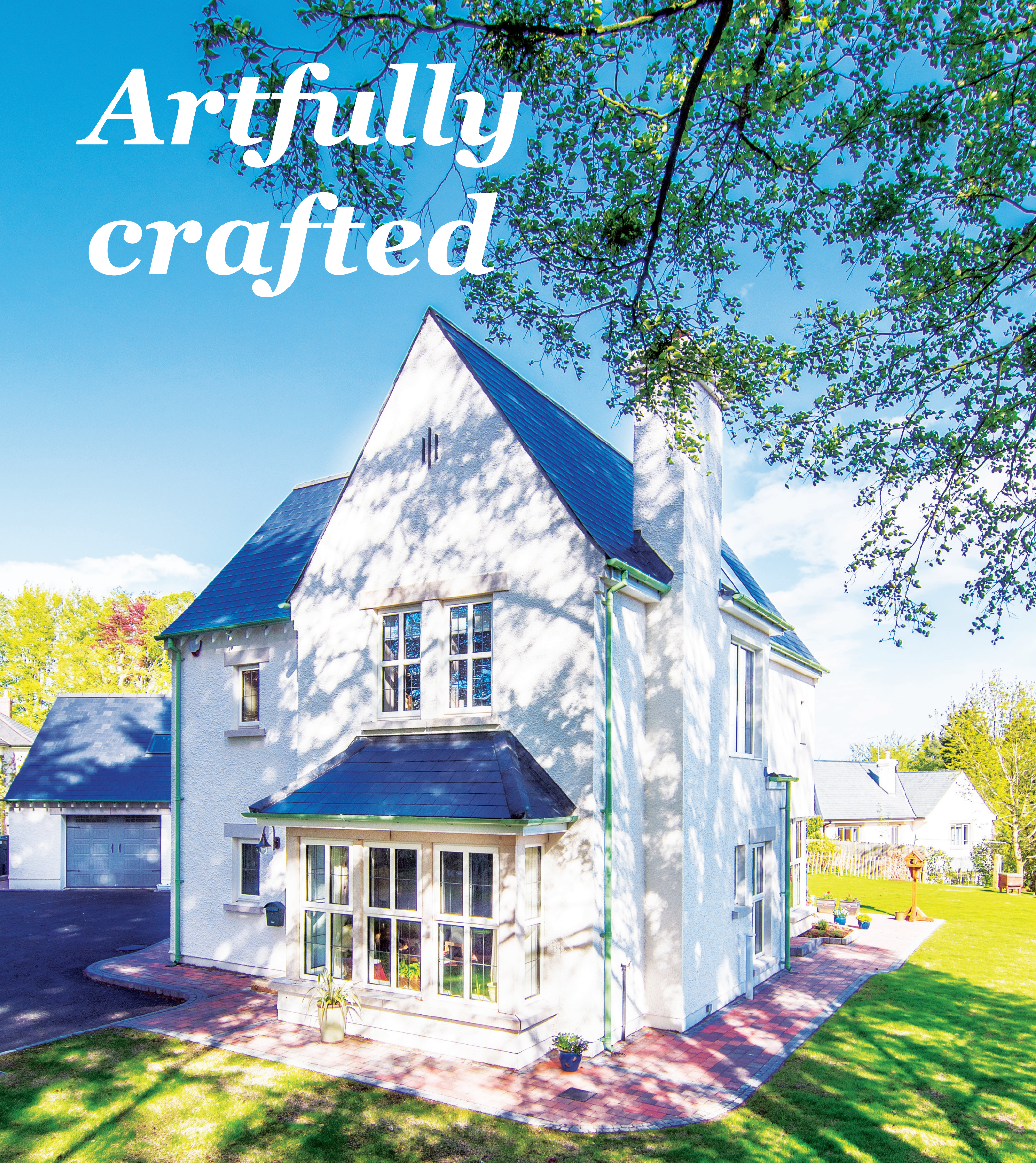
Primary heating system: Daikin Altherma 11kW EHBH16C / ERLQ011CV3 air-to-water heat pump

Ventilation: Zehnder ComfoAir 550 and ComfoAir 800 mechanical heat recovery ventilation systems. Passive House Institute certified heat recovery efficiencies of 84% and 80% respectively.

Electricity: Building mounted array consists of 16 x 205 W Careyglass 60 solar photovoltaic cells. There are a further 150 ground mounted panels (six panels on each of 25 solar-tracking stands). Total array approximately 50kW.

Green Materials: Timber frame, zinc roofing, cedar cladding, LED lighting, water efficient fixtures, rainwater harvesting

Artfully crafted



Tyrone passive house

This new Dungannon home shuns conventional passive house design and embraces the late 19th century Arts and Crafts movement.

Words: John Hearne

Photos: Joe Laverty

When passive house specialist Garrett Quinn of design-and-build practice GP Developments set out to build a home for his parents, he was very careful to avoid the passive house design clichés. This would not be a square, compact building with minimalist styling. In fact, the aesthetic would ignore all of that and take its references solely from the surrounding environment.

"I knew the site would work because the topography and shading were in our favour with tall trees to the north and smaller hedges to the south," he says, "so it had a fairly good aspect, but I wanted to be sure that my parents weren't going to be constrained in any way." As architect Damien McLaughlin of Studio Rogers worked through the design issues with the client, Quinn kept in touch but didn't interfere.

The design which they finally settled on owed a lot to the Arts-and-Crafts era houses found in this part of Dungannon. Featuring high, pointed gables with complex junctions and a distributed footprint, it's about as far from the contemporary German box as you can get.

Though this was his first passive house, Quinn was delighted with the design and the challenge it presented. "I wanted to show that we didn't need to be simple about things, that we could use what was being taught about passive house to be more adventurous. I was confident I could square the circle." The only change he sought before planning was a 200mm reduction in the size of one north elevation window.

Quinn used the passive house software, PHPP, to work through the design and discover the right combination of fabrics and techniques to get all of the variables working within passive house thresholds. To compensate for the complexity of the build, he found he had to bulk up the insulation in key areas. "We have a lot more insulation in the building than we said we would at design approval stage, purely because of the irregular shape." As a result the walls are up to 470mm deep.

An engineer by profession, Quinn went back to school after the construction crash and did a postgrad in renewable energies at the University of Ulster in Jordanstown. It was while working through the green building module that he discovered passive house, and became a convert overnight.

"I knew the way we were building was inherently wrong. There were key things that no one thought about and I was very frustrated with the contradictions in the building regulations. There was no joined up thinking." In particular, he found the regs in relation to airtightness ridiculously lax. As it stands, new builds in Northern Ireland require an airtightness rate of just 10 $m^3/hr/m^2$ at 50 Pa, which translates to roughly 15 times leakier than the passive house standard.[1]

A timber frame system from Setanta Construction was chosen primarily for airtightness purposes. At the time, Quinn felt that timber frame would make it easier to hit the 0.6 air changes per hour (ACH) that passive house requires. The kit also came with 'Easi-Joists', a system which makes it easy for threading services through voids, especially ventilation ductwork.

Understanding just how important craftsmanship and professionalism is when aiming for passive standard airtightness, Quinn says he went through three different squads of joiners before he found a team he was confident could deliver the results he needed. Even then, close policing onsite was vital.

As any passive house builder will tell you, getting below the 0.6 ACH threshold for the first time is as tricky as it is nerve-wracking. Despite Quinn's confidence, the first test revealed problems in the chimney breast, which had been constructed before the timber frame was in place, and before everyone fully understood what would be required to hit the target. With the help of Mark Gribben of Setanta Construction the problem was overcome by 'wrapping it like a parcel' and excluding it from the air test.

Ultimately, the attention to detail and remedial action around the chimney breast paid off. The second airtightness test recorded an ACH of 0.55, well inside the 0.6 target. "I'm extremely proud of that," says Quinn. The result is equivalent to 0.429$m^3/m^2/hr$, roughly 23 times better than building regulations, he says.

Just as he wanted to demonstrate that it was possible to make any home passive, he also wanted to show that you don't need obscure materials to do it. "Bar a couple of items, we can use the components on the shelves of our local builder suppliers to create a passive house," he says, "another myth dispelled."

Quinn originally specified Foamglas blocks to tackle thermal bridging at the footings, but they weren't readily available. Instead he went with Quinn Lite thermal blocks. They worked out perfectly, and have been used on all of Quinn's subsequent builds.

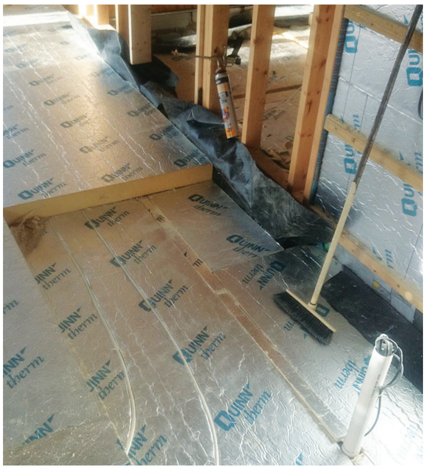
He points out that this key junction is systematically overlooked in conventional houses. "When you have a thermal camera in your hand and you see a building that appears well built, you can see exactly where the heat is leaking out. It's amazing how some of what we think of as our best buildings are actually poorly constructed."

One other interesting feature of this project was the client's insistence on installing an Aga range. "It was bought," says Quinn, "before the foundations were laid."

Keeping the range within the house's energy budget gave Quinn another ball to juggle. It helped that the client opted for an Aga Total Control – an electric version of the iconic range – as opposed to the traditional solid fuel version. "We are able to control how much energy it uses, and keep within our primary energy tolerance, but it's actually proven to be a great asset in the house. On the coldest days, there is this extra heat source that can be turned on if necessary."

Solar overheating is also a risk. The design team was, however, keen to keep the exterior free of the kinds of louvres and brise soleil that would wreck the house's carefully finessed aesthetic. Instead, the design included a strategically placed pergola with the kind of seasonal vegetation that will deliver shading in the summer but wouldn't compromise solar gains in the winter.

For the moment however, Quinn is monitoring conditions in the house to see how Aga heat and solar gains combine as the summer approaches. ▶



(left, top to bottom) The ground floor features a course of Quinn Lite thermal blocks around the perimeter to tackle thermal bridging at the floor-to-wall junction; the timber frame features 140mm deep stud work insulated with Knauf Earthwool; Isover Vario membranes provide airtightness and moisture control for the structure; the ground floor is insulated with 370mm of QuinnTherm PIR insulation

The client has been in the house since Christmas and so far, so great. Temperatures are comfortable and even, and air quality is perfect. In order to minimise the control interface, the house is broken into two zones, upstairs and downstairs, each controlled by a simple, wall-mounted digital stat. If the temperature drops below the set point, a motorised valve releases hot water from the solar array to the ventilation system. A condensing oil boiler provides back up.

"The only thing that they control really is the ventilation system," says Quinn. "If they have a few people over, they'll boost it and if they're going to be away, they'll put it to an unoccupied setting. Apart from that it's automated. They'll always have fresh air in the room, at whatever temperature they want. They're the only controls they want or need."

Quinn says he went through three different squads of joiners before he found a team he was confident could deliver the results he needed

[1]A direct comparison is tricky because building regulations throughout Ireland and the UK express airtightness in terms of the q50 value ($m^3/mhr/m^2$ @ 50 Pa), whereas passive house requires an n50 value (ACH @ 50 Pa). The resulting numbers can vary wildly for larger and more complex buildings, but for typical dwellings they'll tend to be close – so a house that hits 10 $m^3/hr/m^2$ @50 Pa is likely to be close to 10 ACH @ 50 Pa. To explain quite how bad that figure is, it means that with all vents closed, the leakage via the structure is so bad that one complete air change in the house occurs every six minutes at 50 Pascals of pressure (roughly equivalent to 20 mph winds hitting each side of the house).

SELECTED PROJECT DETAILS
Architects: Studio Rogers
Main contractor, passive house design + M&E: GP Developments
Timber frame: Setanta Construction
Airtightness tester: Atlantic Air
Insulations:
Quinn Therm & Knauf, via SIG Insulation Omagh
Airtightness products: Isover
Thermal blocks: Quinn Lite
Windows: Munster Joinery / Baskil
Screeds: CES Quarry Products
Solar thermal: Joule Solar
Oil boiler: Worcester Bosch
Tertiary heating system: Aga TC3 electric cooker
MVHR: Pure Renewable Energy
Rainwater harvesting: Kingspan

PROJECT OVERVIEW:

Building type: 144 sqm detached timber frame house

Location: Dungannon, Co Tyrone, Northern Ireland

Completion date: December 2014

Passive house certification: Pending

Space heating demand (PHPP): 15.1 $kWh/m^2/yr$

Heat load (PHPP): 9 W/m^2

Primary energy demand (PHPP): 118 $kWh/^2/yr$

Airtightness (at 50 Pascals): 0.55 ACH

Energy performance certificate (EPC): Pending

Thermal bridging
Floor to wall: Timber frame on Quinn Lite Q7 blocks, 100mm Quinn Therm PIR on inside surface of timber frame continued to floor insulation
Wall to window/door: all openings and junctions are wrapped in 100mm PIR and connected to thermally broken triple-glazed Munster joinery future proof frames
Wall to roof: 100mm PIR on inside of timber frame continued to roof insulation

Ground floor: Easiflo screed followed underneath by 370mm Quinn Therm PIR insulation, and 150mm concrete slab. U-value: 0.057 W/m^2K.

Walls: 18mm white K-Rend dyed plaster slap-dash externally, on 100mm HW block, on 50mm ventilated cavity, on 12mm OSB, on 140mm studwork insulated with 140mm Knauf Earthwool FrameTherm 35, on Isover Vario KM Duplex UV airtight membrane, on 100mm Quinn Therm PIR insulation, on 25mm service cavity, on plasterboard and skim finish internally. U-value: 0.12 W/m^2K

Roof: Samaca slate externally, on 100mm roof trusses, on 3 x 150mm layers of Knauf Frametherm 35 (bottom 100mm broken by the roof joist), Isover Vario KM Duplex UV airtight membrane, on 100m service cavity, on 15mm plasterboard and skim. U-value: 0.085 W/m^2K

Windows: Munster Joinery Passiv Future Proof uPVC Passive House Institute certified casement window. PHI certified U-value: 0.78 to 0.80 W/m^2K.

Heating system: Joule Vissolis 4.62 square metre solar thermal array, plus 12-18kW Worcester Bosch Greenstar condensing oil boiler, heating a 390 litre buffer tank to 60C for domestic hot water and supplying two water heating batteries in the ventilation system for space heating when required.

Ventilation: Paul Novus 300 mechanical ventilation with heat recovery system. Passive House Institute certified efficiency of 93%.

THE BUILDER'S

Why passive house doesn't cost extra

With this passive house in Co Kildare, father-and-son building team Pat and Paul Doran prove that meeting the strict low energy standard can be done for even less than a 'normal' build – to the tune of a €20,000 reduction in build costs compared to the Department of the Environment's suggested compliance approach.

Words: Paul Doran

In 2013 I built my own low energy home with my father, Pat Doran, a builder with over 30 years of experience. Since then we'd completed a number of low energy projects, but we were eager for the ultimate challenge — building to the passive house standard.

But it's rare to get the opportunity to build a passive house. There are a number of reasons for this, but perhaps the most significant one is cost. The general perception is that the standard is simply one many people cannot afford. As the recent Irish Building Control Act has driven up the costs of construction, this would seem to be more the case than ever.

I would argue however that this is flawed logic, and that the opposite is actually the case. Due to the Building Control Act, Part L (conservation of fuel and energy) of the 2011 building regulations is now being more strictly enforced. All new dwellings built today have to be 60% more energy efficient than they were in 2005. In effect this means every new house built today has to achieve an A3 energy rating.

To me this means there is now little or no difference in the cost of building a passive house and one that complies with regulations. If people are stuck with the cost of an A3 house, why not just build a passive house? In the latter half of 2014 we were presented with an opportunity to do just that. We were engaged to take on the building of a new 290 square metre detached house near Naas, Co Kildare. This was our first house on which the new Building Control Act would apply. It was also to be our first passive house.

During the tendering stage the client accepted this approach with one very important caveat — the house could not cost more than building a dwelling that was merely compliant with Part L. If there was to be extra cost, it would have to be marginal. We were about to find out what the real differences were between

VIEW

Photos: Mark Reddy

the highest energy standard in the world and our current building regs, both in terms of cost and the unique building challenges we would face on site.

To identify exactly what the differences were between a Part L compliant house and a passive house, I referred to a regulatory impact analysis published by the Department of the Environment in 2010, when Part L was being revised. This document included a table of nine dwellings modelled in Deap (Dwelling Energy Assessment Procedure) to meet the new demand for a 60% reduction in energy use over the 2005 regs. One of these dwellings, a 280 square metre detached house, very closely matched our project. During the pricing stage I used it as a benchmark to investigate the difference in cost between building to passive house and just building to Part L.

Whereas a Part L compliant house is evaluated by Deap, the compliance of a passive house is governed by another software program, PHPP. The Passive House Institute promotes PHPP as a tool for designers to ensure that a house will comply with the standard. From a builders' point of view however I also found PHPP to be an excellent costing tool. I could evaluate different build-ups to determine which one was the most cost-effective solution to achieve the required U-value. It could also show me how far we would have to go beyond what Deap would deem sufficient for compliance. This in turn would allow me to identify the difference in cost between the two standards.

The first surprise was that when modelled in Deap the house required a passive level U-value for the floor of 0.15. The table suggested 110mm of PIR insulation under the slab to achieve this. My sense of vindication was short lived however, as this still wasn't low enough for PHPP. It appeared PHPP was pushing me to spend more money on insulation in the floor beyond department guidelines for Part L compliance.

But then I began to investigate further. As PIR under the slab was looking to be an expensive option, I explored the possibility of an insulated raft foundation system. I received a quote for the Viking House passive slab from Airpacks which appeared to be very reasonable. It gave a U-value as low as .09, which was more than sufficient for PHPP. It also eliminated all cold bridges at the floor-to-wall junction.

This was vital for the passive house standard, which is unequivocal in accepting no thermal bridges. Yet how important was it for Part L which specifies thermal bridging should be reduced, '"insofar as reasonably practical". To me this appeared to be a 'get out of jail free card' for having to eliminate cold bridges.

Yet when I went back to the department's guide it required a Y-value of 0.08 and suggested that its acceptable construction details (ACDs) be followed to achieve compliance. When we priced the floor with the PIR board and the ACDs against the Viking House passive slab system, the results were startling. The Viking House foundation was over €5000 cheaper to get to finished floor level.

When it came to the construction stage, however, my father Pat was reluctant. He argued that strip footing was tried and tested, and if anything went wrong it would come back on us. The lower cost of this unconventional approach however wouldn't allow him to discount the idea completely. So I asked Seamus O'Loughlin of Viking House to phone him, and somehow he managed to put Pat's fears at ease.

During construction, however, nobody except Pat was allowed to compact the filling to the structural engineers' specifications. He insisted that carpenters rather than general labour be brought in to assemble the foundation system. As a carpenter by trade himself, he worked with them closely to ensure everything was done right. Throughout the years I had always noticed he took special care with foundations, but on this project it was even more so. To his surprise things went much more smoothly than he had ever seen strip footings work, and it came in on budget.

The next challenge was the walls. The reference house in Deap called for a passive-level U-Value here of 0.14 to achieve compliance with the regs. It suggested 100mm PIR in the cavity and 50mm PIR dry lining to achieve compliance. In our opinion dry lining a new build is not a good idea for a variety of reasons, not least potential problems with mould.

Our preferred option was 150mm of Xtratherm's PIR board in the cavity, which we had used in my own house — with fantastic results in terms ▶

of low heating bills. However PHPP told us this was — by a tiny fraction — insufficient for meeting the passive house standard in this case.

We then considered external insulation, as it would work very well with the Viking House passive slab. In our experience external insulation was expensive, but Steven Magee of Airpacks made us a pitch on their EPS system, and suggested we also use specially rendered sills from Passive Sills in Cork. We priced it all up, and the results again defied the assumption that passive house is too expensive.

An external insulation system with 250mm EPS and U-value of 0.12 was marginally more expensive than the 150mm board in the cavity, with a difference of only a few hundred euro. However the guideline of 100mm in the Cavity and 50mm dry lining was €3000 more expensive.

The external insulation also worked very well during construction. The numerous cold bridging issues from junctions with steel, lintels and sills were eliminated with a continuous wrap from floor to eaves.

When it came to the roof the department guidelines required a U-value of 0.12 for compliance, well within the passive house range. The suggestion to achieve compliance was 150mm PIR between the rafters and 60mm PIR dry-lining below the rafters.

PIR in the roof however was not our preferred option. Instead we preferred to full-fill the rafters on the slope with 300mm of Isover Metac high performance mineral wool. The rafters could then be counter battened for services and the void insulated with another 50mm of Metac. This boosted the U-value on the slope to 0.10. We also put 600mm of standard mineral wool between and over joists on all flat ceilings, bringing the U-Value here down to 0.08. This build-up easily satisfied the requirements of PHPP.

There was also no competition in terms of cost. The cost of the materials alone, if we had used PIR in the roof, would have been €1,000 more than it cost us for supply and fit of all the mineral wool. On top of that we estimated you could easily spend another €3000 on labour as cutting and fitting rigid boards between rafters is extremely time consuming, and you will never get the full-fit possible with mineral wool.

At this stage our passive house was working out nearly €11,000 cheaper than the department's reference Part L compliant 280 square metre detached house. There were still the windows to go however, and passive house insists on triple glazing, which hasn't come cheap in the past. Yet the detached house modelled by the department in Deap required triple glazing to comply with Part L anyway. The client opted for Munster Joinery and their windows and doors had the added bonus of coming with Passive House Institute certification.

When it came to ventilation, however, there was a significant difference between the department's reference house and our passive house. Part L accepts natural ventilation as compliant. Passive house does not accept natural ventilation; mechanical ventilation with heat recovery (MVHR) is required.

If you consider that the cost of installing three extract fans and wall vents came in at less than €1000, and MVHR came in at €6500, this represents a significant extra cost. So how was I able to justify this expense given our brief that any extra expense to the client should only be marginal.

The argument I used was that the extra expense could be offset against the reduced cost of the central heating system. This house is a 290 square metre dormer with four bedrooms, two living rooms, kitchen, utility and office. A standard house of this size would usually require anything in the region of 15 to 20 radiators. With our passive house spec, PHPP calculated that we needed 2550 watts to heat the house to 20C on the coldest day of the year. This could be roughly calculated as three radiators, two big and one small.

I wasn't brave enough, however, to suggest such a small heating system. What if we got a really cold winter? What if the clients felt 20C was cold? Satisfying the parameters of PHPP is one thing, satisfying client preference is quite another. Especially as the perception of temperature in a house is often a subjective experience.

I decided to build some redundancy into the system and asked PHPP how many watts the house would need to reach 25C inside if it was -15C outside. It came back with 7000 watts — or roughly seven radiators — which still represented a saving of €1300 euros in the cost of the rads alone without even taking into account the fittings, piping and labour of installation. From this perspective we were roughly able to half the extra expense of MVHR to €2500, which the client was willing to accept, especially when the added benefits of MVHR in terms of increased ventilation, comfort and health were explained.

There are far cheaper MVHR systems on the market, but there are also horror stories of poor installations and homeowner comfort being severely impaired as a result. This is why we pushed the client to go with a Zehnder system from Flynn Heat Recovery. The owner Maurice Flynn has installed a number of systems for us, including in my own house, and we haven't had a problem yet, which is great reassurance to us as builders. When it came to design we also had the benefit of the services of Darren O'Gorman of Target Zero who managed to keep the whole MVHR system within the thermal envelope — not an easy thing to do on a dormer house.

Airtightness was the other significant difference ▶

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between our passive house and the detached house modelled by the department. The Part L compliant house accepted an air permeability of 5m^3/hr/m^2. This roughly translates to an N50 of 5 air changes per hour (ACH). By contrast the passive house standard requires an onerous maximum air leakage of 0.6 ACH.

Mark Baker of Baker & Co is the only person we will work with when it comes to airtightness. In addition to working with Pat for over twenty years, we have found Mark's advice and experience crucial in getting down below 1.0 ACH on several projects now, while his supply-and-fit price is always the same as it would cost us to buy the materials. On this project Mark's tender price worked out at one per cent of the total build cost, which the client accepted as a marginal extra expense.

Still, we found that during construction achieving the required levels of airtightness was not easy, and the cost of works was harder to quantify beyond the cost of the airtight barriers. Any good builder practices attention to detail, but getting down to 0.6 requires you to take this to a whole new level. Pat spent an inordinate amount of time with trades discussing the details required for complex junctions. Every service penetration to the house had to be identified and planned for. It was harder to timetable the trades at first fix while preserving the integrity of the airtight layer. The trades required far more supervision and support than normal. This ensured that when we came to the final test, there was no problem in reaching 0.6 ACH.

Still all of this represents a cost to the client that many could argue is not there when the air permeability allowed is 5m^3/hr/m^2. It should be borne in mind, however, that there is a consequence for this level of air permeability. When I entered 5m^3/hr/m^2 into PHPP the projected heating bills of the client more than tripled, going from €400 a year in oil to €1,400. So the counter-argument could be made that by sticking to 5m^3/hr/m^2, you're paying for an A-rated house but in reality you're getting mediocre energy performance.

Another extra expense we incurred related to the requirement for renewables under Part L of the building regulations. Under the new Building Control Act, the local authority requires a Part L compliance report at commencement stage. This involved Mark Shirley of 2eva.ie modelling the house in Deap to evaluate it for compliance. As this was a passive house which worked in PHPP, I didn't foresee any problems in Deap. I was wrong.

Mark's evaluation showed that while it passed the energy reduction requirement with ease, comfortably achieving an A2 rating, it failed to comply with the carbon reduction requirement. The house did have an oil boiler but it also had 40 solar tubes, which we assumed was enough to meet the 10kwh/m^2/yr target for renewables. The reason for this failure, Mark explained to me, was that the house was simply too energy efficient. Due to this, there wasn't enough demand for the solar to satisfy the 10kwh/m^2/yr target.

Mark presented us with three options: make the house less energy efficient to increasing heating demand, add solar photovoltaic panels, or ask Kildare County Council to use their discretion in the matter. We went for the third option at first, but got no response.

It certainly didn't make sense to us, the client, or Mark Shirley to make a house less energy efficient in order to achieve Part L compliance. Did this not go against everything Part L was put there to achieve? PV came in too expensive, but working closely with Mark we found that an additional 80 solar thermal tubes (a total of 120 solar tubes) was the most cost-effective solution for compliance.

It was still an extra unnecessary expense of approximately €2000. Other clients could easily have opted for higher fuel bills to save that few thousand during construction. My fear is that this is exactly what will happen if this issue is not addressed.

In the end, the house we built fulfilled passive house requirements without any significant difference in costs to one that was merely Part L compliant. In fact, I estimate a house built to the department's Part L spec would have cost €310,000, whereas built to the passive house standard, this house came in at €290,000. And in terms of running costs, health and comfort levels it is worlds apart from a house that has only ticked the appropriate boxes in Deap. The biggest obstacle to building a passive house is no longer cost – our own building regulations now put standard building costs around the same as passive house – but lack of awareness.

We were aware of the cost-effectiveness of using alternative building methods to those suggested by the department's guidelines, and of the value of the passive house approach as better building practice. The problem is we're in the minority. My big fear as we move forward is that unquestioning conformity to common practice and Part L requirements will lead to a major lost opportunity — where houses are built for the same budget as a passive house, but without any of the benefits.

SELECTED PROJECT DETAILS
Architect: DH Architectural
Contractor: Pat Doran Construction
M&E engineer: Target Zero
Civil & structural engineer: Tanner Structural Designs
Energy consultant & airtightness testing: 2eva.ie
Mechanical contractor: Seamus Byrne Heating & Plumbing
EPS insulation & passive slab supply: Airpacks
Insulated sills: Passive Sills
Roof insulation: Baker & Co
Electrical contractor: Erne Electrical
Airtightness products: Siga
Passive slab design: Viking House
Windows & doors: Munster Joinery
Bi-fold doors: Lakeside Windows
Roof window: Velux, via Chadwicks
Oil boiler: Grant Engineering, via Chadwicks
Solar collectors: Joule, via Chadwicks
MVHR system: Versatile
MVHR contractor: Flynn Heat Recovery
First fix carpentry & roofing: Christy McMahon Carpentry
Second fix carpentry & stairs: David McDonnell Carpentry

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This content is exclusively available to our digital subscribers. ▶

"A house built to the department's Part L spec would have cost €310,000, whereas built to the passive house standard, this house came in at €290,000."

(below) The front facade of the house incorporates a fairly traditional design, though the rear (p59) is more contemporary in appearance; (above) Reynaer's aluminium bi-fold doors, triple-glazed with argon filling and an overall U-value of 1.0 W/m²K; (p61, top to bottom) the house features a Viking House passive slab insulated foundation system; metal web joists create smooth and neat runs for services; thermal bridge free sills from Passive Sills with windows installed proud of blockwork; airtightness detailing with Siga tapes and membranes around the Velux roof window; the Zehnder Comfoair 350 MVHR system; the block-built house was insulated externally with Kore EPS

PROJECT OVERVIEW:

Building type: 250 square metre detached dormer masonry built house

Location: Ballymore Eustace, Co. Kildare

Completion date: April, 2015

Budget: €290,000

Passive house certification: not certified

Space heating demand (PHPP): 18 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 75 kWh/m²/yr

Airtightness: 0.61 ACH at 50 Pa

Energy performance coefficient (EPC): 0.334

Carbon performance coefficient (CPC): 0.355

BER: A2 (47.27 kWh/m²/yr)

Thermal bridging: Viking Passive Slab L-shaped profile connecting 300mm EPS beneath the floor with 250mm EPS on the walls externally, windows fitted externally to the face of block and sitting on EPS Passive sills, 90mm window frames wrapped in EPS, 180mm Metac at wall plate connecting 250mm EPS on walls to 320mm Metac between rafters. Y-value based on PHPP defaults.

Ground floor: Viking House passive slab insulated foundation with 300mm EPS. U-value: 0.9 W/m²K

Walls: Acrylic render externally on 250mm Kore External EPS insulation, on 215mm block on the flat, on sand & cement render internally with skim coat finish. U-value: 0.12 W/m²K

Sloped ceiling: Quinn roof tiles externally on 50x35 battens/counter battens, followed underneath by Pro Clima Solitex breathable roofing underlay, 320mm rafters fully filled with Isover Metac mineral wool, Siga Majpell airtightness membrane stapled to underside of rafters internally, 50mm service cavity insulated with Metac, 12.5mm plasterboard ceiling. U-value: 0.11 W/m²K

Flat Ceiling: Quinn Rooftiles externally on 50x35 battens/counter battens, followed underneath by Solitex breathable roofing underlay, 400mm fibreglass above the ceiling joists, 200mm fibreglass between the joists, Siga Majpell airtight membrane stapled to underside of joists internally, uninsulated 25mm service cavity, 12.5mm plasterboard ceiling. U-value: 0.08 W/m²K

Windows: Munster Joinery Passiv uPVC Passive House Institute Certified triple-glazed windows, with argon filling and an overall U-value of 0.85 W/m²K. Reynaer's Aluminium bi-fold door, triple-glazed with argon filling and an overall U-value of 1.0 W/m²K.

Roof window: Velux MK06 triple-glazed roof window. U-value: 1.0 Wm²K

Heating system: 92% efficient Grant Vortex condensing oil boiler supplying seven radiators and 850 litre Viessmann buffer tank, plus 120 Joule Acapella solar vacuum tubes supplying separate buffer tank

Ventilation: Zehnder Comfoair 350 heat recovery ventilation system — Passive House Institute certified to have heat recovery rate of 84%

PRIVATE ENERPHIT HOMES

COME TO LONDON RENTAL MARKET

Grosvenor's upgrade of two historic properties in Belgravia brings high-end passive housing to Westminster.

Words: Lenny Antonelli

There was a time when few architects would countenance the idea of retrofitting a historic building to the passive house standard. The typical upgrade to such buildings was — and probably still is — a light-touch approach using natural, breathable materials like lime and calcium silicate. Heavily insulating old walls internally has been avoided, for fear of causing condensation and damaging historic structures.

The potential danger is that when you insulate internally you can create a 'dew point' between the new insulation and the old wall where the temperature drops and water vapour condenses to liquid, potentially leading to mould.

But recently, pioneering projects have turned this old logic on its head, using new technology — such as condensation and thermal bridge analysis software, and in-wall moisture monitors — to upgrade historic buildings to modern standards of super-insulation.

Passive house design firm Green Tomato Energy & contractor Princedale Homes broke new ground with the experimental upgrade of historic properties at Princedale Road and Lena Gardens in London to the passive house standard. These

houses were only passive certified on the basis that moisture monitors were installed within the building fabric to watch for possible condensation risks.

Now Sturgis Carbon Profiling (SCP), a London-based sustainability consultancy and architectural practice, has completed the upgrade of two 19th century properties at 11 and 19 Passmore Street in Belgravia, Westminister to the Enerphit standard, the Passive House Institute's benchmark for renovation.

These upgrades are at the forefront of efforts by Grosvenor Great Britain & Ireland, which owns thousands of properties in London, to reduce the carbon footprint of its building stock. Grosvenor is now aiming to reduce the carbon footprint of its property portfolio by 38%, and to get all its properties up to an energy cert of D or higher.

The Passmore Street upgrades are the first of six Enerphits in Grosvenor's pipeline: a third in Mayfair was awaiting certification at the time of writing, two further projects are on site, and one large mixed use building is at design stage.

Grosvenor's retrofit manager, Mike Levey, says passive house offers more practical benefits for Grosvenor than standards like Breeam or Leed. This is because it is entirely focused on building fabric, energy efficiency, comfort and indoor air quality — rather than extraneous factors like transport.

"That's what's going to keep these buildings up for 300 years, not whether you're 300 yards from a church. For us it's about keeping the buildings viable," says Levey. "We are looking to roll [Enerphit] out on more and more projects."

SCP advises Grosvenor on how to reduce the carbon footprint of its buildings. As part of this effort, thirteen properties on Passmore Street received external insulation to their rear facades, plus solar photovoltaic panels. But Grosvenor aimed for Enerphit at the two vacant properties on the street.

Passive-spec timber frame extensions were also built at the back of these two dwellings. The extensions gave the design team more room to play around with inside, so they moved the bathrooms upstairs, and made the ground-floor living areas more open plan.

"Because the houses were small, the extensions actually added quite a lot of floor area," says Maiia Guermanova, architect and certified passive house designer with SCP.

To maintain the historic facades, internal insulation was the only option for the front walls. This meant losing some floor area, and carried the potential risk of condensation, so SCP specified Aerogel insulation — a synthetic, ultralight, breathable and highly insulating material — which delivers a U-value of 0.19 for just 70mm thickness.

Choosing a breathable material helped mitigate the risk of condensation, says Guermanova, while analysis using the Wufi software also indicated that the build-up is safe. The front facades are rendered too, which will help prevent rain and moisture getting into the building fabric.

Designing out thermal bridges — points where cold structures penetrate the insulation layer — also eliminated possible dew points. SCP prepared twenty-six individual thermal bridging details for the retrofit, and carried out 3D thermal modelling of the building's steel supports.

"There is no simple answer to moisture risk on a low energy building," says Will South of Cocreate Consulting, who certified the buildings. "But by ensuring the external brickwork was in good condition, passing the Enerphit air-test target, and providing good levels of internal ventilation, the risks were hugely reduced at Passmore Street. It was also very sheltered in central London."

The whole Passmore Street terrace was externally insulated at the rear with 90mm of Baumit EPS, but the two Enerphits received a further 53mm of PIR insulation internally here too. The roof was insulated with mineral wool and PIR board, which was used internally where moisture risks were low to reduce costs. The party walls were also insulated.

To preserve its historic appearance, SCP specified Green Tomato Energy's mock-sash triple-glazed timber windows to the front facade. While traditional sliding sash windows are impossible to make airtight, these units look like classic sashes but instead open inwards. The rear facades of the Enerphit houses feature passive house certified triple-glazed casement windows.

Naturally with any Enerphit project, airtightness was one of the biggest challenges. This was project manager Grangewood's first passive house project, so SCP provided extensive training in airtightness and other passive house concepts to the builders, and to subcontractors such as electricians and plumbers. The whole team also visited the Target Zero passive house training centre in Ireland before work began on site. A continuous airtightness membrane forms the air barrier for the walls, roof and floor.

Grangewood site manager Paul Hart admits the jobs were demanding, and says the biggest challenge was locating air leaks in old buildings — and finding the right team to carry out such onerous and detailed airtightness work. But the lessons learned at the first Passmore Street project were carried over to the second.

The first airtightness test at No 11 came in at about six air changes per hour (ACH); it took ▶

(below) new externally-insulated extensions to the rear of both Passmore Street projects have made both properties more spacious inside; (p67, top) the roof was insulated with Knauf Earthwool mineral wool insulation; (middle, left to right) Siga Majpell membranes were used to make the structures airtight and to provide vapour control; the party walls — where the risk of condensation was low — were insulated with Kingspan Kooltherm board, while Aerogel insulation was used on the inside of the front facades (bottom, left to right) Baumit EPS external insulation fitted to the rear brick wall; steel beams sit on Foamglas block to prevent thermal bridging; chimney pots were filled with Perlite insulation in to prevent heat loss and provide airtightness

a further two weeks of sealing to get it down to 0.8. But the first test at No 19 came in at 1.2 ACH, and it took just one day's work to get down to 0.9 (the Enerphit target is 1.0).

Hart learned an unexpected lesson from the Passmore Street projects. "We also found that continuous air testing can put the project behind by causing membranes to pull apart at taped joint," he says. Grosvenor had bought their own blower door machine to keep testing during the build, but Hart reckons too much testing can be counter-productive.

Now that Grosvenor, CGS and Grangewood have completed these two dwellings, what other lessons can they take forward into their next batch of Enerphit projects?

Guermanova offers some common sense tips: order components early to allow a longer lead-in time for specialist systems — and to have more time for the detailed work required on site. Allow more time in the build schedule too. Do your first airtightness test as early as possible, but after membranes are fixed with timber battens, otherwise it may balloon and rip off.

Grosvenor's retrofit manager Mike Levey says reaching Enerphit might not have been possible if they had used a normal competitive tender to find a builder, because it would have given a team that was "trying to cut corners right unto the death". Instead Grosvenor chose Grangewood, their preferred builder for domestic retrofits.

The Passmore Street properties are now the first privately-rented Enerphit projects in London, but Levey doesn't believe the rental market knows enough about passive house for Grosvenor to charge a premium. He thinks this will change quickly, however, as consumers become aware of the benefits of passive house — in terms of comfort, health and energy bills.

For Grosvenor, the Passmore Street Enerphits were research projects with larger-than-normal budgets. Levey estimates they ended up costing between 17% and 19% more than one of Grosvenor's typical whole-building upgrades. He thinks they can eventually get this figure down to 5%, but reckons that for retrofitting historic buildings to passive house standards, there will always be a small premium to pay. ▶

These upgrades weren't just about energy and comfort though, but Grosvenor's wider aim of reducing its carbon footprint. SCP carried out a carbon life cycle analysis of the refurbished homes, and found that operational energy will be responsible for just 12% of the building's carbon emissions over a 60 year life cycle, 50-75% less than a benchmark typical retrofit.

Meanwhile, the embodied carbon of retrofit was responsible for 88% of the building's life cycle emissions, of which 19% were for Enerphit 'extras' that wouldn't have been included in a normal retrofit. Most of this came from the use of synthetic insulation materials like PIR and phenolic boards.

But still, SCP found the two buildings combined all save about 840,000 kg of CO_2 equivalent over their lifetime. And making an effort to reuse elements of the building fabric, as well as items like sanitaryware and appliances, could cut this by up to 20% more.

Beyond the five Enerphit projects on its books now, Grosvenor will continue to upgrade some of its buildings to the Enerphit standard when they become vacant. With so many historic properties in London, the standard offers a way of future-proofing their building portfolio.

"That's what will keep those buildings going, and make them better," Levey says. "This is one of the best pieces of real estate in the world, and we want it to remain so."

SELECTED PROJECT DETAILS
Client: Grosvenor Great Britain & Ireland
Architect/ certified passive house designer: Sturgis Carbon Profiling
Project management: Grangewood
M&E engineer: Edward Pearce
Structural engineer: Hurst Pierce & Malcolm
Quantity surveyors: Thompson Cole
Mock sash windows: Green Tomato Energy
Passive house certified casement windows: Zyle Fenster
External insulation: Baumit
Aerogel: Envirofoam Solutions
Insulation boards: Kingspan, Xtratherm
Mineral wool: Knauf
Airtightness tapes & membranes: Siga
Solar PV: Sunpower
Gas boiler: Vaillant

Want to know more?

Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.

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PROJECT OVERVIEW:

Building type: two 1960s solid-brick mid terrace houses, internal floor area of 72.6 square metres. New extensions of 10 sq m.

Location: Passmore Street, Belgravia, London

Completed: January 2015

Budget: confidential

Space heating demand:
No 11: 23 kWh/m²/yr
N9 19: 24.8 kWh/m²/yr

Heat load: 11 W/m² for both units

Primary energy demand (PHPP):
No 11: 127 kWh/m²/yr
No 19: 128 kWh/m²/yr

Environmental assessment method: zero carbon according to Sap. Breeam 'Outstanding' certification pending.

Airtightness (ACH at 50 Pascals)
Before: 32 ACH
After, No 11: 0.8 ACH
After, No 19: 0.9 ACH

Energy performance certificate (EPC)
Before: Both units F (36)
After: Both units A (98)

Existing front wall
Before: Uninsulated 220mm thick solid brick walls
After: Existing 220mm brick wall followed inside by 20mm parge coat, 50mm Aerogel insulation, Siga Majpell vapour control layer & airtightness membrane, 30mm Spacetherm board incorporating 20mm Aerogel and 10mm magnesium silicate board. U-value: 0.19 W/m²K.

Existing back wall
Before: Uninsulated 220mm thick solid brick walls
After: Existing 220mm brick wall finished outside with 90mm Baumit EPS external insulation and 20mm brick slips; internally with Siga Majpell membrane then 53mm Kingspan PIR insulated plasterboard. U-value: 0.18 W/m²K

Existing ground floor (main house)
Before: Uninsulated 150mm thick concrete slab
After: Existing 150mm concrete slab finished above with damp proof membrane, 125mm Kingspan Thermafloor insulation, 65mm screed, floor finish. U-value: 0.18 W/m²K

Existing roof
After: 20mm asphalt weatherproofing, followed beneath by 100mm Kingspan Thermaroof PIR insulation, vapour control layer, 18mm exterior quality plywood, 180-220mm timber joists insulated with Knauf Earthwool, Siga Majpell airtightness and vapour layer, 25 x 38mm timber battens to create service cavity insulated with Knauf Earthwool, ,12.5mm wallboard. U-value: 0.11 W/m²K

Party walls: Existing brick walls followed inside by 20mm parge coat, Siga Majpell vapour control and airtightness membrane, 52.5mm Kingspan Kooltherm phenolic insulation.

Extension ground floor: New 150mm concrete slab finished above with damp proof membrane, 175mm Kingspan Thermafloor PIR insulation, 65mm screed, kitchen floor finish. U-value: 0.13 W/m²K

Extension walls: Baumit render externally, followed inside by 90mm Baumit EPS insulation, 200mm x 50mm timber studs insulted with Kingspan Kooltherm phenolic insulation, 18mm OSB 3, Siga Majpell vapour control & airtightness layer, 47 x 50mm battens to create uninsulated service cavity, 52.5mm Kingspan Kooltherm phenolic insulation internally. U-value: 0.09 W/m²K

Extension roof: 20mm asphalt weatherproofing externally, followed underneath by 120mm Kingspan Thermaroof TR 27, breather membrane, 18 mm exterior quality plywood, 50 x 200mm timber joists insulated with 200mm Knauf Earthwool, Siga Majpell airtight and vapour control membrane, 20mm timber battens for light fittings, 52.5mm Kingspan Kooltherm phenolic insulation. U-value: 0.08 W/m²K

Windows & doors
Before: Traditional single-glazed sash windows to front and single-glazed Crittall steel-framed windows to rear.
New windows: Green Tomato Energy sash look-alike casement windows. Timber frame window/triple-glazing with two low-e coatings and argon filled with TGI spacer. Overall U-value: 1.06. Passive House Institute Certified Zyle Fenster triple-glazed alu-clad timber windows with overall U-value of 0.78 W/²K.

Heating system: Vaillant Ecotec Plus 824 condensing gas combi boiler.

Ventilation
Before: no ventilation system. Reliant on infiltration and opening of windows for air changes.
After: Paul Focus 200 mechanical heat recovery ventilation system, Passive House Institute certified heat recovery efficiency of 91%.

Electricity: 8 x 327W solar panels per house, total array kWp 6.26

Ireland's first *fully passive retrofit*

A new retrofit project in Galway has shown just how far the retrofit of a typical Irish home can go, by bringing a 1960s semi-detached house up to the full passive house standard. The house in Salthill is home to Ciaran Ryan and Mary Hodkinson, who had been living west of Galway City in Furbo, where they had built an energy efficient home in the 1990s.

But they were keen to move to the city, and wanted a comfortable home they would never have to refurbish again. "We're not going to move again after this. We want it to be really cheap to run, we want it to be warm and dry," Ciaran says. They planned to buy an existing house and retrofit to a high standard.

Ciaran had met Irish architect Simon McGuinness through their mutual connections with Cuba — Ciaran runs a piano tuning workshop in Havana, while Simon is involved with the Irish Cuba Support Group. McGuinness had previously built a passive house in Ballymun, Dublin, and came on board as project architect.

McGuinness advised the couple to look for a house with a southerly orientation. Ciaran and Mary sold their house in Furbo and rented another while they looked for an ideal retrofit property. With Ireland's property market having crashed, they didn't expect this to take long. They looked at seven or eight houses, but none were quite right, and house prices were starting to creep up again.

Finally they found a semi-d for sale in Forster Park, Salthill for the right price — and with the front facade facing due south. McGuinness came down to see it. "It's got a nice compact plan, which is very important. The nearer to a cube you can get the house, the easier it is to satisfy the requirements of passive house," McGuinness says. This was crucial, because the budget wouldn't stretch to making up for a lack of solar gain with, say, extra insulation.

But for McGuinness, the project was about more than one house. He also saw it as a chance to demonstrate how far deep a retrofit could go on a typical Irish semi-D. "I was interested in doing it for the sake of proving it was possible to do on a budget," he says.

At the outset, he didn't think it would be possible to achieve full passive house certification. The airtightness target of 0.6 air changes per hour (ACH), he felt, would simply be too onerous. "I didn't think that was possible in a retrofit, because there was no record of anyone having done it," he says. He did, however, guarantee the house would get under 1.0 air changes per hour, the Enerphit standard for retrofit.

The job came with a contractor in tow. Michael Nally & Sons had already built an extension to Ciaran and Mary's house in Furbo, and the couple had been impressed with their workmanship. "Nallys had never built to the passive standard before but were quick to learn. They did the one-day training at Ecological Building systems and quickly got to grips with the specification," McGuinness says.

McGuinness also produced an extremely detailed

This 1960s Galway home was turned into a passive house - and is costing just €55 per year to heat.

Words: Lenny Antonelli

Photos: Kelvin Gillmor

set of drawings for the builders. He felt these details would be useful long beyond this project. "The tender drawings that I produced were very, very comprehensive," he says. "I knew that this was a house type that I would see in my career over and over again." In fact, he actually produced two sets of drawings — one specific to this house, and another more generic set, which can be applied to similar houses in future.

When it came to insulating the building fabric, external insulation was the only real option for the walls. Dry lining internally would have sacrificed too much floor space, and would have risked causing condensation behind the insulation. McGuinness specified an external mineral wool system from Weber, which is breathable and capable of draining moisture away. The flexibility of the material also meant it could be fixed tightly against the pebble-dashed house without plastering first.

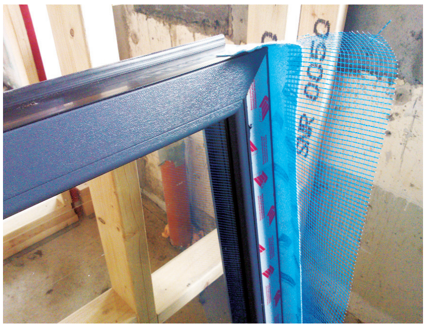
The existing cavity wall was also insulated with platinum polystyrene bead. Meanwhile the concrete roof tiles were removed, and the roof insulated with Rockwool between and above the ceiling joists. A small porch extension was built with externally-insulated Quinn-Lite block, and Munster Joinery's passive-certified Future Proof PassiV PVC windows and doors were installed throughout the house.

As you might expect with a passive house retrofit, airtightness was the biggest challenge. During the design stage, McGuinness drew the airtight layer in blue on all plans, sections and details. Photos were included in the tender demonstrating how to sequence airtightness works. When the builders were on site later, they would upload photos to Instagram for McGuinness to review workmanship remotely.

The airtightness strategy was guided by five principles: a complete wet-plaster finish from floor-to-roof on the inside of the walls, no chased services on the external walls, an airtight membrane under the first floor ceiling, passive house certified windows and doors taped to walls under the wet plaster, and a total removal of the chimney down to the foundations.

All the internal walls were cut back, and skirting boards removed, to ensure total coverage of plaster on the inner face of the external walls. Nally & Sons decided to remove all the internal partitions upstairs, which made it much easier to fit the airtight membrane above. McGuinness wrote about all of these issues, plus airtightness challenges with the slab-to-wall junction, attic hatch and ventilation system, in a previous article for Passive House Plus ('Airtightness: the sleeping giant of energy efficiency' in issue seven).

PHPP, the passive house software, told McGuinness that if the team got the airtightness down from 1.0 to under 0.5 ACH — not as easy a feat as it might sound — the house's space heating demand would drop from 19 to 15kWh/m^2/yr, low enough for full passive house certification. This focused minds on site. "I knew the difference was going to come down to airtightness," he says. ▸



Ultimately, all the detailed drawings and photos paid off. "We only did one blower-door test and we got 0.37 air changes per hour," McGuinness says. "So on that day we all had a pint."

Radon was another challenge on site. "The building is in the highest radon gas risk area in Ireland and has exposed granite bedrock rock present in the subfloor void," he says. To deal with this he specified a stack-based extract system beneath the ground floor slab connected to a radon sump, plus the installation of a radon membrane that's adhered to the airtight layer.

When it came to heating, Ciaran and Mary had originally planned to put in a wood pellet boiler and solar thermal. But when M&E specialist Damien Mullins of Heat Doc came on board, he steered them away from that idea, and towards a Thermia air-to-water heat pump, for the sake of simplicity.

"The cost per kilowatt hour of their machines is very good," Mullins says of Thermia. He says the controls are also excellent, and that the system heats the top of the buffer tank first, so hot water is available instantly. Mullins explains his preference for heat pumps: "They're nearly like white goods. You don't have to worry about topping it up with anything. So it's very clean from a homeowner's point of view."

At Forster Park choosing a heat pump meant just one device, with one installer, and less maintenance, and this helped to save money too. The heat pump heats a 210 litre thermal store, which has an internal coil that sends instant hot water to all of the taps, as well as supplying two radiators on the ground floor, a towel rad in the upstairs bathroom, and a post heater in the Zehnder MVHR supply ducting.

The heat pump gathers information about heat loss from the house, and uses this to decide when it needs to come on, and at what temperature. Often the rads might just come on at 25C for half an hour. "[The heat pump] decides itself what the flow temperature should be," Mullins says. "Once you commission it, there is a short period of tweaking. The short period of tweaking tailors the heat pump to the house, and after that it's matching the heat loss of the house."

The team can monitor the heat pump online to check when it comes on and off, how long it's running for, and what the internal and external temperatures are. In their first year (or 12.3 months, more precisely) since moving in, Ciaran and Mary — who have two grown children living at home — spent just €190 on space heating and hot water, which breaks down as €55 for space heating and €135 for domestic hot water (including €127 from the heat pump and €7 worth of immersion). As McGuinness explains, this is based on applying an average Irish electricity price to the heat pump's metered energy use of just 1117.45 kWh, and excludes VAT, levies, standing charges and utility company special offers.

McGuinness, who lectures at Dublin Institute of Technology, tasked one of his MSc students with working out how much the passive house elements of the upgrade had cost, discounting 'do anyway' items like the new bathroom and kitchen, and changes to the internal layout. He student produced a figure of €84,000, excluding VAT. "That was lower than I expected certainly," McGuinness says.

He believes he can get this down even lower next time. For example, he says creating a zone for MVHR ducting under the first floor ceiling would have been cheaper and easier — from an airtightness perspective — than running all the ducting through the airtight membrane. He had worried about lowering the height of the first floor rooms, but says in hindsight this wouldn't have been an issue.

Ciaran and Mary have been living in the house now for over a year. "There's been no space heating on, probably since the middle of February," Ciaran Ryan says.

"We were almost looking forward to the cold snaps, just to see how does the house behave." His verdict? "It's just spectacular. Everything is a constant temperature. You get up to go to the loo in the middle of the night and the hallway is the same temperature as the bedroom, and the bathroom is the same." One of the biggest challenges when they moved in was finding a duvet thin enough to not overheat under.

"You come in at any stage, and you don't have to worry about getting warm, or putting the heat on, or putting on a coat for the first fifteen minutes until the house heats up," he says. The house received full passive house certification earlier this year, making it the first such retrofit in Ireland.

"Ciaran and Mary knew their budget was too tight but were prepared to compromise on everything except the works needed to achieve passive house certification. Their dedication has been justly rewarded," Simon McGuinness says. "They have shown that the dream of living in a passive house is not the preserve of a wealthy elite. Passive house is for everyone."

SELECTED PROJECT DETAILS
Architect: Simon McGuinness
Contractor: Michael Nally & Sons
Airtightness products: Ecological Building Systems
M&E design & installation: Heat Doc Ltd
External Insulation: Saint-Gobain Weber
Windows & doors: Munster Joinery
Thermal blocks: Quinn Lite
Rainwater goods: Wavin
Hot water cylinder: Dimplex
Cavity insulation: Certainfil
MVHR supplier: Zehnder, via Versatile
Heat pump supplier: Thermia, via Ashgrove
Mineral wool insulation: Rockwool
GGBS: Ecocem

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PROJECT OVERVIEW:

Building type: 142 square metre semi-detached house, built 1970. Full passive house retrofit with small porch extension to south elevation.

Location: Forster Park, Salthill, Co Galway, Ireland

Completion date: April 2014

Budget: €136,000 plus VAT

Passive house certification: Full passive house certification achieved (ref. no. 3173)

Building Energy Rating (DEAP)
Before: F (387.5 $kWh/m^2/yr$)
After: A2 (42.9 $kWh/m^2/yr$)

Space heating demand (PHPP)
Before: unknown
After: 15.14 $kWh/m^2/yr$

Heat load (PHPP)
Before: unknown
After: 13 W/m^2

Primary energy demand (PHPP)
Before: unknown
After: 84 $kWh/m^2/yr$

Measured energy consumption (after): Total heating/DHW energy consumption for first year's occupancy was 1117.45 kWh, or 7.87 kWh/m^2 – or 18.65 kWh in primary energy terms.

Energy bills (after): €15.50 per month or €190 (excl. VAT, levies and standing charges) for space heat and hot water for the year.

Airtightness (at 50 Pascals)
Before: > $10m^3/m^2$
After: 0.4 air changes per hour

Existing ground floor
Before: Uninsulated 150mm concrete floor slab (removed)
After: 22mm Plywood on 25mm SW battens, on 150 mm concrete floor slab, on damp proof membrane, on 200 mm XPS insulation, on radon barier. U-value: 0.116 W/m2K including an adjustment of 0.68

Existing walls
Before: 300mm plastered/rendered concrete block walls with 100mm unventilated air cavity. U-value: 1.82 W/m^2K
After: 180mm Webertherm mineral wool insulation and Weber-rend mineral render finish externally to existing block walls. 100mm Certainfil blown platinum bead insulation into existing cavity. U-value: 0.12 W/m^2K

Existing roof
Before: Concrete tiles on sarking felt, on battens, on timber trusses at 600mm centres with 50mm mineral wool between ceiling joists and plasterboard ceiling. U-value: 0.78 W/m^2K
After: Concrete tiles on breather membrane, on battens, on timber trusses at 600mm centres with 300mm Rockwool above ceiling joists and 100mm between ceiling joists, on existing plasterboard ceiling, on Pro Clima Intelllo airtight membrane, on 25mm service cavity, on new plasterboard ceiling. U-value: 0.11 W/m^2K

Extension walls (small front porch): 180mm Webertherm mineral wool insulation and mineral render finish externally on 215mm aerated Quinn-Lite block with plaster finish internally. U-value: 0.15 W/m^2K.

Extension roof (small front porch): Single ply Sarnafil roofing on 50mm well ventilated air layer, on 200mm EPS insulation, on 100 SW joists at 600 c/c with 100mm mineral wool between, on 18mm OSB airtight layer with 25mm services cavity and plasterboard ceiling. U-value: 0.11 W/m^2K

Windows & doors
Before: Single-glazed, aluminium framed windows and timber doors. Overall approximate U-value: 5.8 W/m^2K
After: Munster Joinery triple-glazed Future Proof PassiV uPVC windows and doors. Passive House Institute certified U-value (installed): 0.85 W/m^2K

Heating system
Before: c.20 year old oil fired boiler & radiators throughout
After: Thermia DHP-AQ 6.7kW air-to-water heat pump with a CoP of 4.17 feeding 210ltr Dimplex thermal store with thermostatically controlled draw-off for two radiators and a towel rail.

Ventilation
Before: No ventilation system. Reliant on infiltration, kitchen extractor, chimney and opening windows.
After: Zehnder Comfoair 350 MVHR with a Passive House Institute certified heat recovery efficiency of 84%. Zehnder manifolds and 80mm diameter Zehnder ConfoTube flexible ductwork.

Green materials: Reused concrete block walls, timber and tile roof and timber intermediate floors; 50% Ecocem GGBS cement; mineral wool insulation throughout. Zero VOC ductwork to MVHR.

(below right) The outdoor unit of the Thermia air-to-water heat pump system; (above) the house's humidity and temperature sensor; (top) deep window sills, created by the use of external insulation, provide space to display artwork; (p73, top) airtightness tapes and membranes were fitted to windows and doors, then taped to the walls on installation before being wet plastered over to ensure a total seal; (bottom, left) the ground floor was insulated with 200mm of XPS insulation; (bottom, right) the masonry walls were insulated externally with Webertherm mineral wool

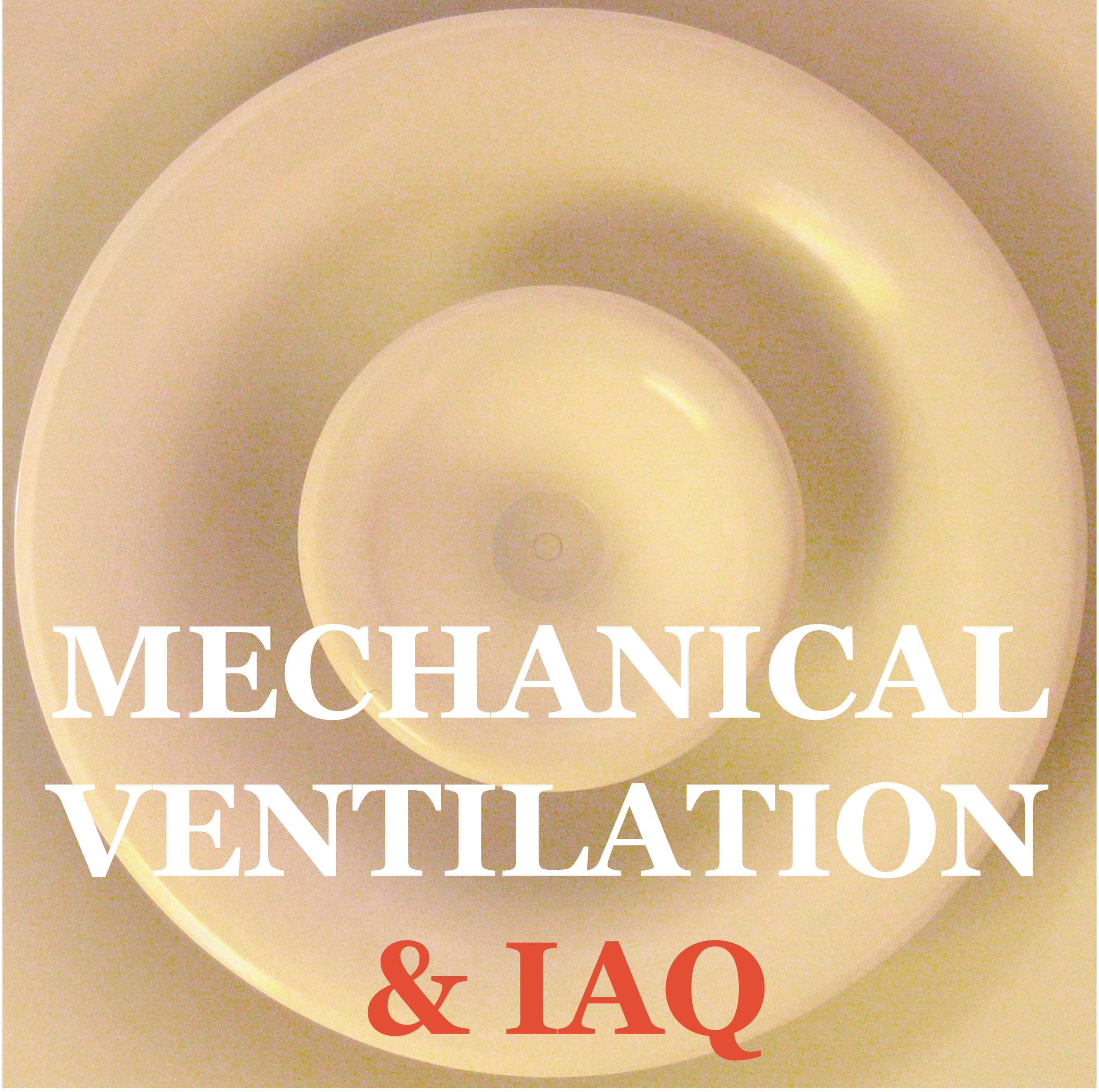


Photo: Michael Angelis

MECHANICAL VENTILATION & IAQ

What the evidence reveals

As previously revealed in Passive House Plus, the evidence appears to indicate that natural ventilation systems don't adequately ventilate our homes. But does mechanical ventilation perform any better?

Words: Kate de Selincourt

The construction industry is slowly grasping the idea that airtightness is important for energy saving and comfort — and is building tighter envelopes. However, for a comfortable, healthy home, airtightness is only half the story — you have to ventilate right too. Is this happening?

A review in issue six of Passive House Plus looked at the evidence on air quality in naturally ventilated homes, and came to the depressing conclusion that the long standing British and Irish norm of holes in the walls or trickle vents in the windows and intermittent extract fans in kitchens and bathrooms, was not resulting in good indoor air quality (IAQ).

One recent study of 20 naturally ventilated new-build houses in Scotland[1] found bedroom CO_2 levels in some bedrooms sitting above 2000 or 2500 parts per million (ppm) on a regular basis (above 1000 is regarded as low indoor air quality, see table). In one home, bedroom CO_2 levels topped 4000 ppm six nights in the monitored week.

Even in leaky homes, 'natural ventilation' fails to deliver reliably good air flow and IAQ. In a range of naturally ventilated homes with airtightness ranging from 5 to 20 ach @50Pa, winter air exchange rates were estimated to vary between 0.2 and 0.7 ach — and the ventilation rate was not closely related to airtightness, which casts doubt on the long standing assumption that infiltration can be seen as part of the ventilation strategy.[2]

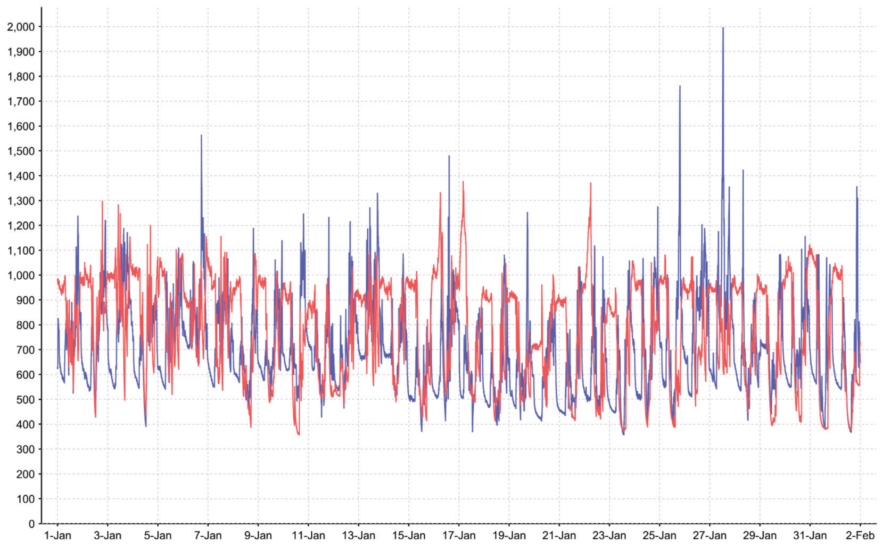
Categories of Indoor Air According to EN13779

Category	Description	CO2 level ppm	Outside Air m^3/h/person
IDA 1	High indoor air quality	< 400	> 54
IDA 2	Medium indoor air quality	400-600	36-54
IDA 3	Moderate indoor air quality	600-1000	22-36
IDA 4	Low indoor air quality	> 1000	<22

Mechanical ventilation in theory offers a better chance of good ventilation – a steady supply of fresh air, independent of the vagaries of wind speed and temperature differentials that drive natural ventilation. Is there any evidence that the theory is right? Does real world MVHR work better than natural ventilation?

At its best mechanical ventilation appears to be both effective and comfortable: "The bungalow has helped enormously health-wise. The clean constant air has helped with my breathing, as I suffer with heart problems and asthma," was the view of one resident in a Gentoo passive house bungalow.[3] Some scientific studies have also suggested that the health of people with respiratory conditions improves when mechanical ventilation is installed in their homes.[4]

Now that mechanical ventilation systems are being introduced more widely, monitoring data is starting to become available. A TSB-funded post-occupancy evaluation of the Wimbish passive house development for Hastoe Housing found that occupants were happy with air quality, 'occupied' CO_2 levels were generally around or below 1000 ppm, and humidity was "within normal limits" (although marginally low in some houses at the end of each winter).[5]



CO_2 monitoring of a passive house at Wimbish: lounge (blue) and bedroom (red), January 2013. The levels are generally acceptable, with the 'spikes' of short duration. CO_2 levels in the flats were lower.

Innovate UK (formerly the Technology Strategy Board) has commissioned an investigation into the performance of MVHR in new build homes in the UK in the form of a 'meta-study', examining the available evidence. Tim Sharpe, Ian Mawditt and Rajat Gupta reported on some of the early findings at Ecobuild in London in March of this year.

Sixteen sets of IAQ readings in eight homes with MVHR showed average night time bedroom CO_2 levels below 1000 for all but one set. Levels only spiked above 1500 between 10% and 30% of the time, in just a couple of the dwellings.

An earlier Technology Strategy Board project evaluated two blocks of twelve flats all fitted with MVHR . Despite some issues with the design and installation, post-occupancy monitoring indicated CO_2 concentrations and humidity levels within normal limits, and occupant satisfaction appeared high.[6] Similar findings have been reported elsewhere.[7]

As an alternative to MVHR, continuous mechanical extract ventilation (MEV) is cheaper and easier to install, especially in a retrofit situation. However, without heat recovery, MEV is unlikely to be as energy efficient, although in some systems, "demand control" has been introduced, in a bid to counter energy losses by cutting ventilation rates when less fresh air is needed, as determined by humidity sensors in the extract.

There is not much post-occupancy monitoring data available for MEV systems. However, one study[8] (by manufacturer Aereco along with research partners) in two blocks of flats in France, fitted with centralised demand-controlled MEV, showed night-time CO_2 in bedrooms remaining mainly below 1000 ppm (or below 1200 ppm, in a bedroom housing four adults). A study of a house in Belgium, also fitted with DCMEV, found night time CO_2 levels remained at or below 1000 ppm for six of seven nights of monitoring.[9]

It is hard, though, to make direct comparisons between mechanical and natural ventilation, as studies were carried out at different times in different places . One report gets a bit closer to this by including both naturally ventilated and MVHR-ventilated dwellings in the same study.

This study examined a group of recently-constructed Scottish homes, and although most were naturally ventilated, half a dozen homes had MVHR included.[10]

The performance of the ventilation in the houses with MVHR systems was reported to be "generally better" than for the naturally ventilated homes: "average winter CO_2 is 858 ppm for the MVHR houses, compared with 1292 ppm for the naturally ventilated houses."

A 'natural experiment' took place in one of the houses in this study when the occupants switched off the MVHR in the summer and increased their window opening instead. Strikingly, the ventilation rate deteriorated in the summer despite the windows being open — IAQ was better in the winter with windows closed but MVHR running.

Comfort is an air quality issue

The picture is not all rosy; reports of faulty mechanical ventilation systems are not hard to find, and there are examples of pretty poor practice out there: fan units bolted to bedroom ceilings, filters that cannot be accessed to change, missing insulation, squashed and tangled ducts and ducts that are not connected, incorrect terminals, and even entire units connected up the wrong way round.

Mechanical ventilation can 'underperform' owing to:
a) inadequate design/installation/commissioning impacting on flow rates in part or all of the dwelling;
b) occupants turning the ventilation down or off – eg through discomfort, anxiety or not understanding the system.

Noisy or draughty ventilation leads some users to turn down their ventilation, or at worst turn it off altogether, and they may or may not start opening their windows to compensate.[11] Ventilation may also be turned down by commissioning engineers, for the same reason. Noisy ventilation may also increase the perception of energy use — and indeed, may well be increasing energy use — again, a reason for switching off.

Noise is the commonest complaint. For example, Paul White, design and quality manager of the Town and Country Housing Association, carried out research on 20 residential units with MVHR, and found only 10 were switched on, and only two households used the boost setting: "Sound is a significant issue," he reported.[12] ▶

Reasons for noise (and draughts)

- **Noisy fan unit (or undersized)**
- **Fan unit in badly chosen location, eg above bedroom ceiling**
- **Lack of sound separation at fixings**
- **Lack of sound attenuators in ductwork**
- **Poor choice of and/or location of supply & extract terminals (eg just above likely position of bed head) - may also lead to draughts**
- **Commissioned at too high a fan speed (may also lead to dry air/discomfort & excessive energy use). NB Part F requires quite high ventilation rates, which can lead to high noise levels, and also dry air, and may also lead to draughts**
- **Kinked/blocked ducts or filters making fan work harder**
- **Automatic 'boost' setting too sensitive to 'normal' conditions, which may also lead to draughts**
- **Uninsulated duct cooling extract air and thereby increasing RH and triggering boost, which may also lead to draughts[13]**
- **Incorrect terminals may also lead to draughts**

Not many studies have recorded both air quality and information about the state of the ventilation system. However in one study in London of homes with MVHR there were a significant number of recordings of CO_2 levels above the target 1000 ppm, and it was reported that some of the systems were faulty with low flow rates or missing ducts, while some systems were not switched on at all.[14]

A couple of studies have either deliberately or accidentally encountered occupied homes where the MVHR was known to be turned off and the windows were known to be closed.

In one small study this scenario was deliberately tested in two prototype low energy dwellings.[15] These houses were moderately airtight (at around 4 ach at 50 pascals),though not to passive house standards.

perceptions of MVHR in social housing,[16] housing and building professionals are quoted using expressions like "people turning the damn things off, they "fiddle" or "tamper" with the systems, or "screw them up" , along with slightly patronising references to occupants "needing a certain level of awareness", or "I think it is education...them getting used to it".

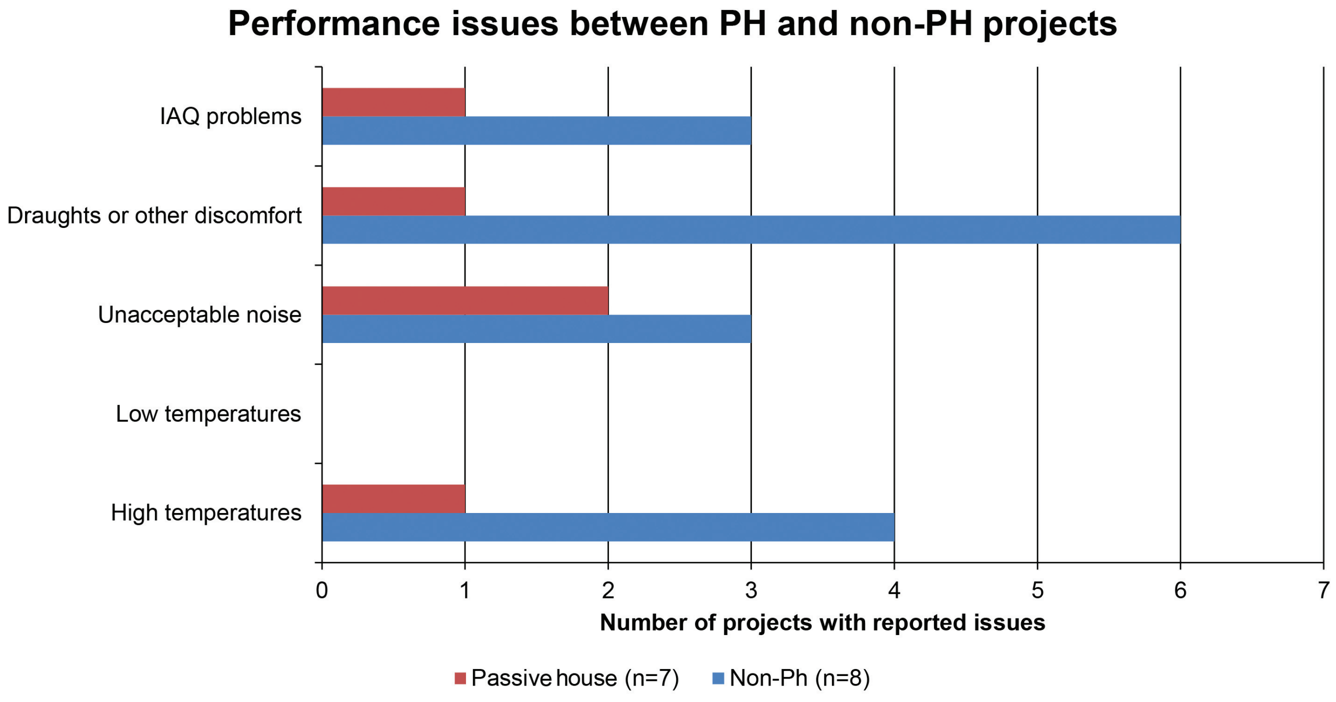
Even when the professionals recognised the system was causing discomfort, the implication was sometimes that these actions were taken out of ignorance: "If they feel any cold draught or anything at all then they will block it up because they don't understand what they are trying to do," was another comment from the study.

As a result, effort is sometimes put into tamper-proofing systems – by wiring the ventilation into the lighting circuits for instance.

of the heat recovery, and, therefore the temperature of the supply air (this is not covered in part F).

Once built, 19 of the 20 passive houses had measured flow rates that matched the design rate (though two were border line). However 21 out of 34 non passive house systems failed to match the (not always adequate) design.

The more effective designs and installations in the passive houses appear to be echoed in occupant satisfaction, although so far occupant feedback is available for just 15 of the homes. In this small sample, six out of seven passive house occupants appeared satisfied with IAQ and comfort, and five out of seven with noise levels, but at least six out of eight of the non-passive house occupants had a complaint about IAQ, and/or noise, and/or draughts.



The 'experimental' occupants (student volunteers) spent a week with the ventilation turned off and the windows closed. Night-time CO_2 in the bedrooms was above 2000 ppm, indicating inadequate ventilation.

Similar situations have arisen briefly in passive house buildings by accident: in a brief period where the MVHR was switched off in one passive house, CO_2 averages rose to just below 2000 pm in the living room and over 2000 ppm in the bedroom.

Clearly these results indicate poor air quality in the absence of a functioning MVHR, though it may be worth bearing in mind that such data as there is indicates similar air quality in naturally ventilated homes, such as the Scottish study reported above.

Occupant misunderstanding or misuse?
There is a school of thought that MVHR, in particular, is too difficult for ordinary occupants to live with. Sometimes occupants are also blamed for "interfering". In a study into professional

Yet it also seems probable that a badly designed and installed mechanical ventilation system, that is noisy and uncomfortable, is more likely to be interfered with by occupants who are only asking for a quiet, comfortable life. Better installations might reduce the incidence of tampering. Comfortable systems are therefore more likely to deliver good indoor air quality.

Passive house on top
So some mechanical ventilation systems do seem to be working well, while others, clearly are not. What is the clue to the difference?

The Innovate MVHR meta-study[17] now has system design and installation information on the MVHR in 54 dwellings – a mixture of passive house and non-passive house. Analysis shows that all 20 passive house dwellings had a ventilation design whose flow rate met part F, but only around 50% of non passive dwellings clearly did so. Furthermore one third of the non passive house designs were not balanced, which would affect flow rates in different rooms, the efficiency

As another example, occupants of the passive house Lancaster Co-housing development also reported high satisfaction with their homes in a building user survey, including with the air quality: none said the ventilation was noisy, in fact some commented that you couldn't actually hear it to tell whether it was running.

Technically, we know good mechanical ventilation is possible and has been delivered many times. But clearly there are still practical obstacles to getting it right every time. Consultant Ian Mawditt believes there is something to be drawn from the relative success of passive house ventilation systems.

"From what I have seen so far, it's clear that the passive house installations work better than non passive house ones. This seems to be a function of the way quality is embedded in the whole build process with passive house; everyone is tied in to delivering quality, almost micromanaged.

"It is not so much an issue of passive house itself, so much as just getting it right. If we did

wet systems the way ventilation generally gets installed, there would be water all over the floor, it wouldn't be tolerated, obviously. Yet because its air, people just don't get it — the installers, the commissioners, the users, they don't care or just don't notice."

Ian Mawditt's colleague in the Innovate MVHR meta-study, Tim Sharpe of the Mackintosh School of Architecture, feels that a big problem with non-passive house MVHR is sometimes that no-one in the design team quite knows why it's there.

"Too often the presence of MVHR is nothing to do with a desire for good air quality, but is purely driven by the numbers in SAP. The architect doesn't think about it at all, until the SAP assessor recommends MVHR, so the architect just writes 'MVHR' on the drawings. That's not a ventilation strategy, that's a compliance strategy.

"People are perceiving MVHR as an energy measure, like insulation, and forgetting it's actually there to supply fresh air."

What's different about passive house?

- **There is a requirement for specific design noise levels in rooms**
- **The energy losses from ducts are calculated and minimised**
- **Commissioning includes requirement for balanced ventilation**
- **Commissioning is reviewed by a certifier who is experienced in MVHR**
- **Also a general emphasis on quality, workmanship, and supervision**

Occupant info

Occupants in all kinds of homes (even leaky ones) need to understand their ventilation. It is pretty clear that many of us either don't know how our ventilation is meant to work, don't care, or just can't bear the discomfort.

If design and installation is good enough, the last of these issues should go away, but we do still need to know that ventilation is important, and be able at least to tell if our system is working properly.

It is a fair criticism of many MVHR systems, that, like many heating systems, the controls are unnecessarily complicated, and often incomprehensible.

Yet this really isn't necessary. The advantage with mechanical ventilation is that unlike natural ventilation, the air flow can be controlled quite well with a few simple controls. And in practice, occupants who ignore the controls and leave the MVHR on "normal" all the time have been seen to achieve good indoor air quality anyway.[18]

What occupants do require is the basic information about what their ventilation system is and how it works. This requires a clear chain of communication all the way from the designer right the way to the end user, and that communication is as much part of the performance of the system as the ductwork layout.

Training

Although a 'competent person' scheme for ventilation installations was introduced with the 2010 update to part F (England & Wales), it is still possible for a system to be installed by trades such as plumbers or electricians with no specialist knowledge, with the 'competent person' being the site manager, who may not even be on site. As a result there have been calls for everyone involved to receive adequate qualification and training.[19]

This is a performance gap issue. In the UK, the Zero Carbon Hub is trying to tackle very similar problems in relation to energy performance. Some very broad brush estimated costings have been carried out for the Hub for a set of measures, including workforce training, to improve construction quality.

Adam MacTavish at Sweett Group costed a suite of measures including energy literacy training, with certification or 'carding' of site team members via a short training course , and estimated this would only add around £100 on the cost of each home.

Additional measures such as robust construction details, improved testing etc could be added for around the same again, he told Ecobuild. By effectively spreading the extra cost over a 20-year mortgage, MacTavish calculated that the 'net present value' of the proposed £200 uplift was equivalent to just £14 per year.

Might house-buyers and landlords feel they could put a similar annual value on good air quality and restful sleep? These are two of the main advantages of a well-functioning ventilation system, and as it happens were picked out in a recent European survey as the top householder priorities for healthy living.[20]

In the UK the Zero Carbon Hub is working on the basis that industry can be brought round to accepting some kinds of 'as built' certification on energy performance. There seems to be a very strong case for ventilation performance to be treated similarly.

But there is clearly some way to go, and as Ian Mawditt puts it: "I believe right now we are on a learning curve and unfortunately there will be collateral damage. I am seeing signs of improvement, but alas it is still marginal, it is less than I would have hoped."

And customers are complaining – rightly so. Ian Mawditt feels that customer complaints may be one of the most potent drivers for change.

"Some installations are so awful that the occupants make a fuss, and actually I think this is essential. I have come across a case where the ventilation was so bad that a group of residents came together in an action group to get the developer to put things right.

"This could be one of the most effective things to improve industry practice. It's awful for the people living with the bad ventilation but if they complain, the developers do get very unhappy and they tend to act quite quickly."

Ian Mawditt added that the "collateral damage" need not mean permanent harm: "Very few MVHR systems are beyond retrieval." Sometimes it is a fairly simple matter of recommissioning, sometimes more intervention is needed, but it's almost always fixable: "I see some awful systems, but only a handful where I have not been able to go away having resolved the problem to give acceptable air flows."

Ian Mawditt added that however painful for those involved, a couple of high profile lawsuits might be more effective still – and he believes one or two lawsuits might even be in the pipeline.

It was a delegate at a 2013 Good Homes Alliance event who summed up the options to his colleagues: "Do you want to put budget into doing a good job, or into rectifying a bad one and defending your poor workmanship in court?"

Mechanical ventilation is an unfolding story in the UK and Ireland. Research is ongoing and more evidence is to come. There are problems, but there are also a lot of homes with really good, comfortable ventilation which the occupants are very happy with. And there appear to be straightforward solutions to the problems we do find. As Ian Mawditt put it: "It's not rocket science."

At its best, domestic mechanical ventilation offers good air quality, excellent comfort and benefits to health, all without using more energy than natural ventilation, and, hopefully, using less. The question is, do we have the will to give everyone the best? And if not, why not?

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